A MANUAL OF PUBLIC HEALTH AND SANITARY SCIENCE.

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A

MANUAL OF PUBLIC HEALTH AND SANITARY SCIENCE.

A PRACTICAL GUIDE TO THE PUBLIC HEALTH (SCOTLAND) ACT, 1867, AND THE LOCAL GOVERNMENT (SCOTLAND) ACT, 1889;

FOR THE USE OF

COUNTY COUNCILLORS, MEMBERS OF DISTRICT COMMITTEES, AND THEIR OFFICERS UNDER THESE ACTS.

BY

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PREFACE.

The author of this little work, in the performance of the duties of a medical officer of health, has felt the want of a practical guide to the Public Health (Scotland) Act, and this has been shared by many brother medical officers who have spoken to him on the subject. And further, by the passing of the Local Government Act for Scotland, duties under the Public Health Acts, which must be entirely unfamiliar, have been transferred to new administrators of these Acts, more than ever the want of a practical guide in sanitary matters will be experienced. In the hope that this volume will, at least to a certain extent, supply the want, the author ventures to place it at the disposal of sanitary administrators and advisers under the Local Government Act for Scotland. Several excellent guides to the Local Government Act and Public Health Acts have recently appeared, but these treat the subjects from the legal, and not at all from the medical or sanitary aspects. As many of the questions involved can only be found scattered over the pages of many treatises on the science of Public Health, by the concentration and arrangement of these in relation to the practical working of the Public Health Act for Scotland, it is hoped that this manual will succeed in actually being a practical guide to County Councillors, Members of District Committees, and their Officers in their various duties as administrators and advisers in sanitary matters.

The author begs to acknowledge the valuable assistance and advice of several friends in passing the work through the press, and specially that of Mr. Chisholm, LL.B., Barrister and Advocate; and for the preparation of the Index, the Rev. John Nasmyth.

April 1890.

TABLE OF CONTENTS.

—o—

INTRODUCTION.

Local Government (Scotland) Act, 1890.

PAGE

Public Health Acts transferred to County Councils — Appointment of Medical Officers and Sanitary Inspectors—Qualifications—Rivers Pollution Act—Bye-Laws by County Councils—Provision for Special Drainage or Water Supply Districts, ... 1–6

CHAPTER I.

Public Health (Scotland) Act, 1867.

Terms used — Duties of Local Authorities—Appeal by Householders or Procurator-Fiscal — Refusal or Neglect of Duty by Local Authority —Order by Sheriff, Magistrate, or Justice to carry out Improvements—Police to assist in Management of Act—Forms used—Action under Common Law not impaired—Purchase of Land otherwise than by Agreement—Duties of Medical Officers and Sanitary Inspectors, . 7–20

CHAPTER II.

Removal of Nuisances.

Nuisances defined—Nuisances in Section XVI. Subsection (A)—Houses—Insufficiency of Size—Defect of Structure—Site—Soils—Air and Water in Soils—Conformation of Soils—Physical and Chemical Conditions affecting Soils—Defects of Walls, Roofs, Floors—Materials for Walls—Dampness and Remedies—Thickness—Roofs—Rhones—Conductors — Traps — Rain-water Collectors — Floors — Materials used—Oak Boards useful, ... 21–37

CHAPTER III.

Ventilation.

Need of Air — Composition — Vitiated in Mines — Towns — Oxygen, Nitrogen, Carbonic Acid, effects of—Ozone, action of, where found—Aqueous Vapour — Relative Humidity — Organic Matter offensive and dangerous—Ammonia and Albuminoid Ammonia—Impurities in Air — Animal, Vegetable, Mineral, Metallic, Gaseous — Impurities from Respiration and Transpiration—Combustion—Principles of Ventilation—Mechanical Ventilation—Special Ventilators—Examination of Room—Cubic Space, how measured—Temperature—Moisture—Chemical Examination of Air, ... 38–62

CHAPTER IV.

Defects of Houses due to Want of Repair and Proper Drainage.

PAGE

Water-closets, Privies, Cesspools—Kinds used—Situation and Construction of Water-closets—Connection with Soil Pipes—Failure of Water-closets—Trough Closets—Glasgow and Hull—Middensteads—Dry-Earth System—Duties of Local Authorities in Subsection (A)—Petition for Order for Admission to Premises—Forcible Entry—Medical Certificate—Penalties, ... 63-77

CHAPTER V.

Section XVI. Subsection (B).—Drains and Sewers.

Pools—Watercourses—Gutters—Construction of Sewers and Drains—Soil Pipes—Traps—Kinds—Manholes—Grease Traps—Main Drains and Sewers—Composition of Sewage—Survey of Sewerage Area—Materials for Sewers—Gradients—Flushing—Ventilation—Shone's System—Liernur's Sewage Disposal—Precipitation—Filtration—Irrigation—Duties of Local Authorities—Sewers belong to Local Authority—Must be kept Clean—Users to comply with Regulations—Local Authority can compel Drains for Houses, etc.—Special Sewerage District—Importance of Sewerage and Drainage—Improved Health, . 78-98

CHAPTER VI.

Section XVI. Subsection (B).—Water and Water Supplies.

Suitable Waters—Composition—Analysis of good—Usable and Impure Water—Sources of Water—Rain—Evaporation—Percolation—Quantity needed—Rainfall as Water Supply—Pollution and Dangers of—Springs—Subsoil Water—Gauging of Springs—Wells—Shallow, Deep—Pollution of Wells, and Prevention—Kinds of Wells—Beardmore—Artesian Wells—Tube Wells—Rivers and Streams—Pollution—Purification by Oxidation and Subsidence—Medical Reports as to Supply by Rivers—Upland Surface Waters—Reservoirs—Distribution of Water—Action of Waters on Lead Pipes—Storage of Water in Houses—Rules for Water Companies, ... 99-124

CHAPTER VII.

Section XVI. Subsection (B).—Purification of Water.

Filters—Materials used—Household Filters—Charcoal—Carferal—Asbestos and Charcoal—Pasteur-Chamberland Filter—Distillation—Boiling—Exposure to Air—By Chemical Means (Clarke's Process)—Sanitary Importance of Water—Effects of Defective Supply—Of Suspended Mineral Matters—Of Dissolved Mineral—Of Metallic Impurities—Of Suspended Animal and Vegetable Impurities—Diseases associated with Organic Pollution—Cholera—Typhoid—Parasites—Powers and Duties of Local Authorities—Penalties for fouling Water—Notices to Defaulters, ... 125-135

CHAPTER VIII.

SANITARY EXAMINATION OF WATER.

PAGE

Physical Tests—Colour—Taste—Smell—Microscopical—Koch's Test—Methods of making Nutrient Jelly—Of filling Flasks and Tubes—Preparing Bread Paste—Apparatus needed—Plate Cultivations—Examination of Cultivation—Method of Inoculation into Nutrient Jelly or Bread Paste—Chemical Methods—Total Solids—Chlorides—Phosphates—Hardness—Nitrates—Nitrites—Oxygen removal Process—Ammonia and Albuminoid Ammonia—Lead—Copper—Iron, . 136–151

CHAPTER IX.

SECTION XVI. SUBSECTION (C).

Stables—Ventilation of Byres, Dairies, and Cowsheds, and Milkshops Order, 1885—Circular from Board of Supervision—Pig-styes—Powers and Duties of Local Authorities under Subsection (C)—Subsection (D)—Collection and Storage of Rubbish—Fryer's Destructor—Powers and Duties of Local Authorities, ... 152–168

CHAPTER X.

SECTION XVI. SUBSECTION (E).—WORKS, TRADES.

Business of Blood Boiler—Bone Boiler—Tanning—Slaughtering of Cattle—Of other Animals—Soap-boiling—Business of Skinner—Tallow-melting—Tripe-boiling—Manufacture of Artificial Manure—Of Glue and Size—General Recommendations for Disposal of Filth—Powers and Duties of Local Authorities—Form for Subsection (E)—Penalties—Subsection (F)—Subsection (G)—Factories—Workshops—Ventilation of Bakehouse—Regulations—Subsection (H)—Fireplaces and Furnaces—Smoke—Causes and Abatement—Powers and Duties of Local Authorities—Subsection (I)—Churchyards—Soils—Site—Petition to Sheriff, ... 169–188

CHAPTER XI.

PART III. OF ACT 1867.—ORDER IN COUNCIL.
PART IV. OF ACT 1867.—ISOLATION HOSPITALS.

Situation and Site—Temporary—Permanent—Village Hospitals—Hospital Construction — Ventilation — General Arrangements — Rules for Management — Mortuaries — Disinfection — Disinfectors — Fraser's, Scott's, Ransome's, Lyon's—Dr. Parsons' Report—Disinfection by Boiling — Chemicals — Gaseous — Liquid — Solid — Disinfection of Room, Drains, Cesspools—Powers of Local Authorities for Prevention and Mitigation of Disease—Disinfection—Mortuary—Penalties for Letting Houses not disinfected—Ships—Infected Persons—Notification of Infectious Diseases—Vaccination, ... 189–221

CHAPTER XII.

Part V. of Act 1867.—Common Lodging-Houses.

PAGE

Register—Inspection—Water Supply—Notification of Infectious Diseases—Cleansing of Premises—Rules and Regulations for Common Lodging-houses—Notices to be served for Water Supply—Infectious Diseases, etc.—Houses let in Lodgings—Cellar Dwellings, . . . 222-230

CHAPTER XIII.

Unsound Food.

Diseases of Animals — Pleuro-Pneumonia — Cattle Plague—Murrain—Charbon—Tuberculosis—Trichinosis—Pig Typhoid—Variola Ovina—Variola Vaccinia—Measles of Pig—Parasites—Iuspection of Meat—Conditions justifying Seizure—Poultry—Game—Fish—Fruit—Vegetables—Flour—Bread—Order for Destruction or Disposal of Unwholesome Meat—Food aud Drugs Act, ... 231-245

ERRATA.

After "temperature of dry bulb" add "and deduct from latter temperature," six lines from bottom, p. 53.

For "sewerage" read "sewage," p. 81.

INTRODUCTION.

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THE LOCAL GOVERNMENT ACT FOR SCOTLAND, which last year became law, has, amongst other things, made most important changes in the administration of matters relating to public health. Prior to the passing of this Act, Parochial Boards, acting as Local Authorities, administered the various Public Health Acts. This is to continue no longer, and, as stated in section 11 of the Local Government (Scotland) Act, 1889, "Subject to the provisions of this Act, there shall be transferred to and vested in the council of each county, on and after the appointed day, or at such times as are in this Act in that behalf respectively specified :—

"(4.) The whole powers and duties of the Local Authorities under the Public Health Acts of parishes so far as within the county (excluding burghs and police burghs)."

It will thus be seen that burghs and police burghs retain the powers they formerly had as regards sanitary administration. In a subsequent section of the Act, as will afterwards be seen, the powers and duties regarding public health matters are retransferred to the district committees.

In the Act, section 52, the provisions as to powers of County Councils in regard to sanitary administration are thus described:—

(1.) The council of every county shall appoint and pay a medical officer or medical officers and a sanitary inspector or sanitary inspectors, who shall not hold any other appointment or engage in private practice or employment without express written consent of the council.

(2.) The County Council and any district committee, as the Local Authority under the Public Health Acts, may from time to time make and carry into effect arrangements for rendering the services of such officer or officers regularly available in the district of the district committee, on such terms as to the contri-

bution by the district committee to the salary of any medical officer or sanitary inspector, or otherwise, as may be agreed, and the medical officer or sanitary inspector shall have within such district all the powers and duties of a medical officer or sanitary inspector appointed by a district committee.

(3.) So long as such an arrangement is in force, the obligation of the district committee as the Local Authority under the Public Health Acts to appoint a medical officer or sanitary inspector shall be deemed to be satisfied without the appointment of a separate medical officer or sanitary inspector.

Sect. 53.—(1.) Every medical officer and sanitary inspector under the Public Health Acts for a district in any county shall send to the County Council a copy of every report of which a copy is for the time being required by the regulations of the Board of Supervision (which they are hereby authorized to make) to be sent to that Board.

(2.) If it appears to the County Council that the Public Health Acts have not been properly put in force within any district, or that any other matter affecting the public health of the district requires to be remedied, the Council may cause a representation to be made to the Board of Supervision on the matter.

Qualifications of Medical Officer and Sanitary Inspector.

Sect. 54.—(1.) No person shall hereafter be appointed the medical officer of any county or district or parish, unless he is a registered medical practitioner.

(2.) No person shall, after the first day of January, one thousand eight hundred and ninety-three, be appointed the medical officer under the Public Health Acts for a county or district or parish which contained, according to the last published census for the time being, a population of thirty thousand or upwards, unless he is qualified as above mentioned, and also is registered on the medical register as the holder of a diploma in sanitary science, public health, or State medicine under section twenty-one of the Medical Act, 1886.

(3.) No person shall, except with the express consent of the Board of Supervision, be appointed as the sanitary inspector of a county unless he has been during the three consecutive

years preceding his appointment, the sanitary inspector of a Local Authority under the Public Health Acts.

(4.) Every medical officer and every sanitary inspector appointed under the Act or under the Public Health Acts shall be removable from office only with the sanction of the Board of Supervision.

Sect. 55.—(1.) On and after the appointed day a County Council shall have power, in addition to any other authority, to enforce the provisions of the Rivers Pollution Prevention Act, 1876 (subject to the restrictions in that Act contained), in relation to so much of any stream as is situate within, or passes through or by, any part of their county, and for that purpose they shall have the same powers and duties as if they were a sanitary authority within the meaning of that Act, or any other authority having power to enforce the provisions of that Act, and the county were their district.

(2.) Any County Council shall have power to contribute towards the expenses of any prosecution under the said Act instituted by any other County Council or by any sanitary authority.

(3.) The Secretary for Scotland, by provisional order made on the application of the council of any of the counties and burghs concerned, may constitute a joint-committee or other body representing all the counties and burghs through or by which a river, or any specified portion of a river, or any tributary thereof, passes, and may confer on such committee or body all the powers of a sanitary authority, under the Rivers Pollution Prevention Act, 1876, or such of them as may be specified in the order; and the order may contain such provisions respecting the constitution and proceedings of the said committee or body as may seem proper, and may provide for the payment of the expenses of such committee or body by the counties and burghs represented by it, and for the audit of the accounts of such committee or body, and their officers.

A provisional order made under this section shall be of no effect until it is confirmed by Parliament.

Sect. 57.—(1.) "The council of a county may from time to time make such bye-laws as to them seem meet for the administration of the affairs of the county;" amongst other things, "for prevention and suppression of nuisances not already punishable in a summary manner by virtue of any Act in force throughout

the county, and may thereby appoint such penalties, not exceeding in any case five pounds, as they deem necessary for the punishment of offences against the same."

Powers of District Committees.

Sect. 17. With respect to the transference to the County Council of the powers and duties of certain Local Authorities under the Public Health Acts, the following provisions shall have effect:—

(1.) For the purposes of the administration of the laws relating to public health, the county shall, except as hereinafter provided, be divided into districts in the manner provided in this Act, and there shall be a district committee for each such district constituted as provided in this Act.

(2.) A district committee shall, subject to the provisions of this Act, be the Local Authority under the Public Health Acts, and as such shall have and may exercise within its district all the powers and duties and be subject to all the liabilities by this Act transferred to or conferred on the County Council with respect to administration of the laws relating to public health, except those relating to medical officers or sanitary inspectors for the county and subject to the provisions following:

(*a*) A district committee shall have no power of raising money by rate or loan:

(*b*) The County Council shall make general regulations for the government of a district committee, and such committee shall conform to those regulations:

(*c*) Any five ratepayers in the district may appeal from any proceedings or order of a district committee to the County Council, who shall have power to confirm or vary or rescind such proceedings or order; and such proceedings or order shall be stayed pending the appeal, but the power of appeal hereby given shall not apply to any proceedings for the removal of a nuisance; and nothing in this Act contained shall affect or prejudice any proceedings to enforce the provisions of the Public Health Acts, save only that

when necessary such proceedings shall be taken by or against the district committee instead of against the Parochial Board as Local Authority under the said Acts. The medical officer or the sanitary inspector of the county or district may appeal to the County Council, and the County Council may on such appeal make an order under the Public Health Acts.

(3.) The power of appointing officers under the Public Health Acts is hereby varied, so that it shall be lawful to appoint such officers either for the whole district or for any part thereof or parish therein, as shall be deemed expedient. The officers so appointed shall have, as nearly as may be, within the areas respectively assigned to them, the same powers, duties, rights, and tenure (if any) as the officers, as the case may be, of the existing Local Authority have within the area of the parish.

(4.) The sums necessary to meet any deficiency in respect of the expenditure under the Public Health Acts within any district shall be levied by the County Council by a rate imposed on all lands and heritages within such district, or within any special drainage or water supply district within the meaning and subject to the provisions of the Public Health Acts.

Provision for Special Drainage or Water Supply Districts.

Sect. 81.—With respect to special drainage districts or special water supply districts the following provisions shall have effect:—

(1.) Where a special drainage district or special water supply district has been formed in any parish under the Public Health Acts, the district committee may, subject to regulations to be from time to time made with the consent of the County Council, appoint a sub-committee for the management and maintenance of the drainage or water supply works, and such sub-committee shall in part consist of persons, whether members of the district committee or not, who are resident within the special drainage district or special water supply district;

(2.) Where a special drainage district or special water supply

district is partly within a county and partly within a burgh or police burgh, the sub-committee appointed under the immediately preceding subsection and such number of the town council or police commissioners (as the case may be) of such burgh or police burgh as failing agreement the Secretary for Scotland may determine, having regard to all the circumstances of the case, shall be charged with the management and maintenance of the drainage or water supply works within such special district, and the determination of the Secretary for Scotland may provide for the regulation of the proceedings and for the allocation and payment of the expenses incurred under this subsection;

(3.) Where a special drainage district or special water supply district is wholly within a police burgh formed after the passing of this Act, the Police Commissioners of such police burgh shall become the Local Authority under the Public Health Acts for such special district, and the assessments in respect of the drainage and water supply shall be levied in the same manner as they were before such district was formed into a police burgh.

Sufficient has now been quoted from the Local Government (Scotland) Act, 1889, to show what powers and duties County Councils and district committees respectively have in the administration of the Public Health Acts. After the formation of district committees, the County Councils will transfer to them the administration of sanitary matters, but they will still exercise supervision over them by means of the medical officer and sanitary inspector for the county.

District committees will exercise all the powers formerly held by Parochial Boards as Local Authorities administering the Public Health (Scotland) Act, 1867, and various other Acts in relation to public health. In a circular issued by the Board of Supervision in 1867, the general scope of the Act was indicated, and the responsibilities of Local Authorities in dealing with the important subjects of the Act were fully pointed out; but unfortunately, as all sanitarians know, and as expressed by the Lord Advocate when introducing the Local Government Bill for Scotland, the Act has been a "dead letter."

CHAPTER I.

PUBLIC HEALTH (SCOTLAND) ACT, 1867.

In the preliminary part of the Act, interpretations of important terms occurring therein are given; and as they are very important, they are now given as in the Act.

III. In this Act the following words and expressions shall have the meanings hereinafter assigned to them, unless such meaning is inconsistent with the context:—

The word "Board" shall signify the Board of Supervision for the Relief of the Poor in Scotland:

The word "secretary" shall include assistant secretary:

The expression "medical officer" shall signify a duly qualified medical practitioner appointed under the Act Eighth and Ninth Victoria, chapter eighty-three, or under this Act:

The word "Sheriff" shall include Sheriff-Substitute:

The word "burgh" shall include not only royal burgh, parliamentary burgh, burgh incorporated by Act of Parliament, burgh of barony, and burgh of regality, but also any populous place having a town council, police commissioners or trustees exercising the functions of police commissioners under any general or local Act.

The word "magistrate" shall include a magistrate or judge having police jurisdiction under the General Police and Improvement (Scotland) Act, 1862, or under any general or local Police Act which may be in force:

The word "decree" or "decern" shall include any warrant, sentence, judgment, order, or interlocutor:

The word "owner" shall signify the person for the time entitled to receive, or who would, if the same were let, be entitled to receive, the rents of the premises, and shall include a trustee, factor, tutor, or curator, and in case of

public or municipal property shall apply to the persons to whom the management thereof is intrusted:

The word "ship" shall include any sailing or steam ship, vessel, or boat:

The word "premises" shall include lands, buildings, structures of any kind, streams, lakes, drains, ditches, or places open, covered, or inclosed, and any ship, lying in any sea, river, harbour, or other water, or *ex adverso* of any place within the limits of the Local Authority:

The word "person," and words applied in this Act to any person or individual, shall apply to and include women, corporations, clubs, societies, statutory boards or commissioners, joint-stock companies, partnerships, joint owners, and joint occupants, and trustees:

The word "company" shall apply to and include commissioners:

The expression "author of a nuisance" shall signify the person through whose act or default the nuisance is caused, exists, or is continued, whether he be the owner or occupier, or both:

The expression "common lodging house" shall signify a house or part thereof where lodgers are housed at an amount not exceeding fourpence per night for each person, whether the same be payable nightly or weekly, or at any period not longer than a fortnight, or where the house is licensed to lodge more than twelve persons:

The expression "keeper of a common lodging house" shall include any person having or acting in the care and management of a common lodging house.

IV. "The Lands Clauses Consolidation (Scotland) Act, 1845," and "The Lands Clauses Consolidation Acts Amendment Act, 1860," shall, for the special purposes hereinafter mentioned, be incorporated with and form part of this Act, and shall be hereinafter referred to as "The Lands Clauses Acts."

General Duties of Local Authorities.

In section XCIX. of the Public Health (Scotland) Act, 1867, the following important statement is made regarding the duties of Local Authorities:—"It shall be the duty of the Local Authority to make from time to time, and also when required by the Board,

either by themselves or by their officers, inspection of the district, with a view to ascertain what nuisances exist calling for abatement under the powers of this Act, and to enforce the provisions of the Act in order to cause the abatement thereof; also to enforce the provisions of any Act that may be in force within its district requiring fireplaces and furnaces to consume their own smoke. Where a nuisance is situated in a district the Local Authority of which does not cause the same to be abated, and which nuisance is offensive or injurious to another district, the Local Authority of the latter district may call on the first-mentioned Local Authority to take all competent steps for removal of such nuisance; and the said first-mentioned Local Authority shall be bound to do so accordingly, and any expense thereby occasioned to the said second - mentioned Local Authority shall be reimbursed by the first - mentioned Local Authority, the amount of such reimbursement in the case of dispute to be finally determined by the Board."

From the foregoing it will be seen that there is a certain responsibility incurred by Local Authorities when they neglect their duties, and it is no excuse to plead that they were not aware of the existence of an alleged nuisance, their duty being to discover it by the means in their power, and to take the necessary steps for its removal or abatement. Further, one Local Authority may call on another Local Authority to deal with a nuisance in the district of the latter.

By section XCVI., if a Local Authority neglect its duty under this Act, it shall be competent for any two householders residing within the district, or for the inspector of poor of the parish, or for the Procurator-Fiscal of the Sheriff or Justice of the Peace Court of the county, or of the Burgh Court, or for the Board, to give written notice to such Local Authority of the matters in which such neglect exists; and if the Local Authority do not, within fourteen days after such notice, or in the case of neglect to enforce any regulation or direction of the Board under Part III. of this Act, within two days after such notice, remove or remedy the nuisance referred to, or in any other case neglect to take the steps authorized or required by or under this Act, it shall be competent for the parties aforesaid, or any one of them, to apply to the Sheriff by summary petition; and the Sheriff shall thereupon inquire into the same, or may make such decree as shall in his

judgment be required. The remainder of this section pertains to the duties of the Sheriff.

Section XCVII. provides for refusal or neglect of a Local Authority to perform its duties under the Act. The Board may, with the consent of the Lord Advocate, apply by summary petition to either Division of the Court of Session, or to the Lord Ordinary in case of vacation or recess, which Division or Lord Ordinary are authorized and directed to do therein, and to dispose of the expenses of the proceedings, as shall appear just.

In section XCVIII. it is stated that the Procurator-Fiscal of the Sheriff Court, on the Board being satisfied that the Local Authority have made default in doing their duty, may, with the consent of the Lord Advocate, institute and follow out proceedings against the Local Authority for compelling them to do so.

Section CXIII. provides for the case of occupier of premises preventing owner carrying into effect provisions of the Act. If on application, sheriff, magistrate, or justice think certain works necessary, they shall order in writing the occupier to permit such works being carried out; and if within reasonable time he refuses to do so, he becomes liable to a fine not exceeding five pounds for every day afterwards during the continuance of such refusal.

In the following section it is provided, that for violating the Act or obstructing its execution a person is liable to a fine not exceeding five pounds for each offence, unless in cases where a special penalty is mentioned.

Section CXVIII. provides that a Local Authority is not liable for irregularities of its officers; and a subsequent section provides that police constables are to aid in executing the Act.

Forms contained in the schedule to the Act annexed, or any forms to the like effect, may be used for the purposes of the Act; and all written proceedings or documents under this Act may be wholly or partly printed.

The sheriff, justices of the peace, or magistrates, being members of a Local Authority, are not debarred from exercising their jurisdiction under this Act. Section CXI. is important, and is as follows: "Copies of any orders or regulations of the Local Authority or their committee purporting to be signed by the

chairman of such body or committee, and all directions and regulations or orders or resolutions of the Board signed by their secretary or clerk, shall, unless the contrary be shown, be received as evidence thereof without proof of their meeting, or of the official character or signature of the person signifying the same."

In Section CII. it is stated that a Local Authority may appear and plead before any sheriff, magistrate, or justice, or in any legal proceedings, by any officer or member or other person authorized generally, or in respect of any special proceedings by resolution of such authority.

Section CV. All applications may be by summary petition, and such petition need only refer to the clause of the Act on which it is founded; and the sheriff, magistrate, or justice may appoint the petition to be answered within three days after service, or may order the parties to attend him in person. The other section deals with Court procedure and other legal matters. The last section of the Act states that the Act does not impair right of action in respect of nuisances at common law.

Regulations to be observed with respect to Purchase and Taking of Land otherwise than by Agreement.

The following regulations are of the utmost importance when it is necessary for a Local Authority to apply for a Provisional Order to put in force the powers of the Lands Clauses Acts for any purpose for which the acquisition of land is necessary:—

(1.) The Local Authority, before putting in force any of the powers of the said Lands Clauses Acts with respect to the purchase and taking of land, shall—

Publish once at least, in each of three consecutive weeks in the month of November, in some newspaper circulated in the district or some part of the district " within which such Local Authority has jurisdiction is situate " (*sic*), an advertisement describing shortly the purpose for which the land is proposed to be taken, naming a place where a plan of the proposed works may be seen at all reasonable hours, and stating the quantity of land that they require; and shall further in the month of December—

Serve a notice in manner hereinafter mentioned on every owner or reputed owner, lessee or reputed lessee, and occupier of such land, defining in each case the particular land intended to be taken, and requiring an answer, stating whether the person so served assents, dissents, or is neuter in respect of taking such land; such notice to be served—

By delivery of the same personally to the party on whom it is required to be served; or if such party is absent abroad, to his agent; or

By leaving the same at the usual or last known place of abode of such party as aforesaid; or

By forwarding the same by post in a registered letter addressed to the usual or last known place of abode of such party;

(2.) Upon compliance with the provisions hereinbefore contained with respect to advertisements and notices, the Local Authority may, if they shall think fit, present a petition to one of Her Majesty's Principal Secretaries of State (Secretary for Scotland); the petition shall state the land intended to be taken, and the purposes for which it is required, and the names of the owners, lessees, and occupiers of land who have assented, dissented, or are neuter in respect of the taking such land, or who have returned no answer to the notice; it shall pray that the Local Authority may, with reference to such land, be allowed to put in force the powers of the said Lands Clauses Acts with respect to the purchase and taking of land otherwise than by agreement; and such prayer shall be supported by such evidence as the Secretary of State (Scotland) requires.

(3.) Upon the receipt of such petition, and upon due proof of the proper advertisements having been published and notices served, the Secretary of State (Scotland) shall take such petition into consideration, and may either dismiss the same or direct an inquiry in the district in which the land is situate, or otherwise inquire as to the propriety of assenting to the prayer of such petition; but until such inquiry has been made in the district, after such notice as may be directed by the Secretary of State (Scotland), no Provisional Order shall be made affecting any

land without the consent of the owners, lessees, and occupiers thereof.

(4.) After the completion of the inquiry as last aforesaid, the Secretary of State (Scotland) may, by Provisional Order, empower the Local Authority to put in force, with reference to the land referred to in such Order, the powers of the said Lands Clauses Acts with respect to the purchase and taking of land otherwise than by agreement, or any of them, and either absolutely or with such conditions and modifications as he may think fit; and it shall be the duty of the Local Authority to serve a copy of any Order so made in the manner and upon the person in which and upon whom notices in respect of such land are hereinbefore required to be served.

(5.) No Provisional Order so made shall be of any validity unless the same has been confirmed by Act of Parliament; and it shall be lawful for the Secretary of State (Scotland), as soon as conveniently may be, to obtain such confirmation; and the Act confirming such Order shall be deemed to be a Public General Act of Parliament.

(6.) All costs, charges, and expenses incurred by the said Secretary of State (Scotland) in relation to any such Provisional Order as last aforesaid shall, to such amount as the Commissioners of Her Majesty's Treasury think proper to direct, become a charge upon the assessment or special water supply assessment levied in the district or special water supply district, as the case may be, to which such Order relates, and be repaid to the said Commissioners of Her Majesty's Treasury by annual instalments not exceeding five, together with interest after the yearly rate of five pounds in the hundred, to be computed from the date of any such last-mentioned Order, upon so much of the principal sum due in respect of the said costs, charges, and expenses as may from time to time remain unpaid.

Those somewhat complicated and extensive proceedings must be carefully carried through, as where opposition is made to any proposed acquisition of land, advantage is usually taken of any flaw. The process urgently requires simplification, and where land is wanted for any sanitary purpose, power should be given to County Councils to grant this, after due inquiry certainly, but without causing any undue loss of time or expense, as

happens under the present cumbrous arrangements. Land for such purposes should be granted at its fair market value, and not at a ransom price, as too often happens.

The following conditions are to be kept in remembrance by Local Authorities, as stated in section XXV. :—

Nothing in this Act contained shall enable any Local Authority or other person to injuriously affect—

(1.) The irrigation of lands in a rural district or the supply of water used for such irrigation.

(2.) The supply of water required for the purposes of any waterworks established by Act of Parliament, or of the compensation water required to be given by the owners of such waterworks, unless the Local Authority shall have previously obtained the consent of such owners.

(3.) The navigation on or use of any river, canal, dock, harbour, loch, reservoir, or basin in respect of which any persons are by virtue of any Act of Parliament entitled to take tolls or dues, or the supply of water to the same, or any bridges crossing the same, or any towing-path thereon.

It is further provided that a Local Authority cannot interfere with quays, docks, etc., without consent of the persons entitled to take dues or tolls; and such persons may alter drains, sewers, etc., interfering with docks, quays, etc., providing others equally sufficient.

This short *résumé* of the general powers and duties of Local Authorities under the Public Health (Scotland) Act does not exhaust the subject, but their special duties will be described more fully, and in direct relationship to the matters which have to be dealt with in sanitary administration.

It is of the greatest importance that medical officers of health and sanitary inspectors should have clear ideas of their respective important duties, and these cannot be better described than in the rules issued for the guidance of these officers by the English Local Government Board.

Duties of Medical Officer of Health.

1. He shall inform himself, as far as practicable, respecting

all influences affecting or threatening to affect injuriously the public health within the district.

2. He shall inquire into and ascertain by such means as are at his disposal the causes, origin, and distribution of diseases within the district, and ascertain to what extent the same have depended on conditions capable of removal or mitigation.

3. He shall by inspection of the district, both systematically at certain periods and at intervals as occasion may require, keep himself informed of the conditions injurious to health existing therein.

4. He shall be prepared to advise the sanitary authority on all matters affecting the health of the district, and on all sanitary points involved in the action of the sanitary authority or authorities; and in cases requiring it, he shall certify, for the guidance of the sanitary authority or of the justices, as to any matter in respect of which the certificate of a medical officer of health or a medical practitioner is required as the basis or in aid of sanitary action.

5. He shall advise the sanitary authority on any question relating to health involved in the framing and subsequent working of such bye-laws and regulations as they may have power to make.

6. On receiving information of the outbreak of any contagious, infectious, or epidemic disease of a dangerous character within the district, he shall visit the spot without delay and inquire into the causes and circumstances of such outbreak, and advise the persons competent to act as to the measures which may appear to him to be required to prevent the extension of the disease, and, so far as he may be lawfully authorized, assist in the execution of the same.

7. On receiving information from the inspector of nuisances, that his intervention is required in consequence of the existence of any nuisance injurious to health, or of any over-crowding in a house, he shall, as early as practicable, take such steps authorized by the statutes in that behalf as the circumstances of the case may justify and require.

8. In any case in which it may appear to him to be necessary or advisable, or in which he shall be so directed by the sanitary authority, he shall himself inspect and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, or flour exposed for sale, or deposited for the purpose

of sale, or of preparation for sale, and intended for the food of man, which is deemed to be diseased, or unsound, or unwholesome, or unfit for the food of man; and if he find that such animal or article is diseased, or unsound, or unwholesome, or unfit for the food of man, he shall give such directions as may be necessary for causing the same to be seized, taken, and carried away in order to be dealt with by a justice according to the provisions of the statutes applicable to the case.

9. He shall perform all the duties imposed upon him by any bye-laws and regulations of the sanitary authority duly confirmed in respect of any matter affecting the public health, and touching which they are authorized to frame bye-laws and regulations.

10. He shall inquire into any offensive process of trade carried on within the district, and report on the appropriate means for the prevention of any nuisance or injury to health therefrom.

11. He shall attend at the office of the sanitary authority, or at some other appointed place, at such stated times as they may direct.

12. He shall from time to time report in writing to the sanitary authority his proceedings and the measures which may require to be adopted for the improvement or protection of the public health in the district. He shall in like manner report with respect to the sickness and mortality within the district, so far as he has been enabled to ascertain the same.

13. He shall keep a book or books, to be provided by the sanitary authority, in which he shall make an entry of his visits, and notes of his observations, and instructions thereon, and also the date and nature of applications made to him, the date and result of the action taken thereon, and of any action taken on previous reports, and shall produce such book or books whenever required to the sanitary authority.

14. He shall also prepare an annual report, to be made at the end of December in each year, comprising tabular statements of the sickness and mortality within the district, classified according to diseases, ages, and localities, and a summary of the action taken during the year for the preventing the spread of disease. The report shall also contain an account of the proceedings in which he has taken part or advised under the Sanitary Acts, so far as

such proceedings relate to conditions dangerous or injurious to health, and also on account of the supervision exercised by him, or on his advice for sanitary purposes, over places and houses that the sanitary authority has power to regulate, with the nature and results of any proceedings which may have been so required and taken in respect of the same during the year, in regard to offensive trades, bakehouses, and workshops.

15. He shall give immediate information to the Local Government Board of any outbreak of dangerous epidemic disease within the district, and shall transmit to the Board, on forms to be provided by them, a quarterly return of the sickness and deaths within the district, and also a copy of each annual, and any special report.

16. In matters not specifically provided for in this Order, he shall observe and execute the instructions of the Local Government Board on the duties of medical officers of health, and all the lawful orders and directions of the sanitary authority applicable to his office.

17. Whenever the Diseases Prevention Act of 1855 is in force within the district, he shall observe the directions and regulations issued under that Act by the Local Government Board, so far as the same relate to or concern his office.

The above important directions, although issued by the English Local Government Board, are applicable to all medical officers of health, and for the efficient discharge of the various duties involved, imply that those officers must be specially trained, and have a special knowledge of the subjects of hygiene and public health. Further, as their duties will bring them into delicate relationship with those whose interests may be thereby affected, it cannot be too carefully borne in mind that the utmost tact is necessary, and that argument and persuasion should be used, rather than any attempts by compulsion. The medical officer of health should be the sanitary teacher, rather than the compulsory attendance officer; the sanitary authority taking the place of the latter.

Order of Local Government Board (England) as to Duties of Sanitary Inspectors.

(1.) He shall perform, either under the special directions of the sanitary authority, or (so far as authorized by the sanitary

authority) under the directions of the medical officer of health, or in cases where no such directions are required, without such directions, all the duties specially imposed by the Sanitary Acts, or by the Orders of the Local Government Board.

(2.) He shall attend all meetings of the sanitary authority when so required.

(3.) He shall by inspection of the district, both systematically at certain periods, and at intervals as occasion may require, keep himself informed in respect of the nuisances existing therein that require abatement under the Sanitary Acts.

(4.) On receiving notice of the existence of any nuisance within the district, or of the breach of any bye-laws or regulations made by the sanitary authority for the suppression of nuisances, he shall, as early as practicable, visit the spot, and inquire into such alleged nuisance or breach of bye-laws or regulations.

(5.) He shall report to the sanitary authority any noxious or offensive businesses, trades, or manufactories established within the district, and the breach or non-observance of any bye-laws or regulations made in respect of the same.

(6.) He shall report to the sanitary authority any damage done to any works of water supply, or other works belonging to them, and also any case of wilful or negligent waste of water supplied by them, or any fouling, by gas, filth, or otherwise, of water used for domestic purposes.

(7.) He shall from time to time, and forthwith upon complaint, visit and inspect the shops and places kept or used for the sale of butcher's meat, poultry, fish, fruit, vegetables, corn, bread, or flour, or as a slaughter-house, and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, or flour which may be therein; and in case any such articles appear to him to be intended for the food of man, and to be unfit for such food, he shall cause the same to be seized, and take such other proceedings as may be necessary in order to have the same dealt with by a justice: Provided that, in any case of doubt arising under this clause, he shall report the matter to the medical officer of health, with the view of obtaining his advice thereon.

(8.) He shall, when and as directed by the sanitary authority, procure and submit samples of food or drink, and drugs suspected to be adulterated, to be analysed by the analyst appointed under

the Adulteration of Food Act, 1872; and upon receiving a certificate stating that the articles of food or drink or drugs are adulterated, cause a complaint to be made, and take the other proceedings prescribed by that Act.

(9.) He shall give immediate notice to the medical officer of health of the occurrence within his district of any contagious, infectious, or epidemic disease of a dangerous character; and whenever it appears to him that the intervention of such officer is necessary, in consequence of the existence of any nuisance injurious to health, or of any overcrowding in a house, he shall forthwith inform the medical officer thereof.

(10.) He shall, subject in all respects to the directions of the sanitary authority, attend to the instructions of the medical officer of health with respect to any measures which can be lawfully taken by him under the Sanitary Acts for preventing the spread of any contagious, infectious, or epidemic disease of a dangerous character.

(11.) He shall enter from day to day, in a book to be provided by the sanitary authority, particulars of his inspections, and of the action taken by him in the execution of his duties. He shall also keep a book or books, to be provided by the sanitary authority, so arranged as to form, as far as possible, a continuous record of the sanitary condition of each of the premises in respect of which any action has been taken under the Sanitary Acts, and shall keep any other systematic records that the sanitary authority may require.

(12.) He shall at all reasonable times, when applied to by the medical officer of health, produce to him his books, or any of them, and render to him such information as he may be able to furnish with respect to any matter to which the duties of inspector of nuisances relate.

(13.) He shall, if directed by the sanitary authority to do so, superintend and see to the due execution of all works which may be undertaken under their direction for the suppression or removal of nuisances within the district.

(14.) In matters not specifically provided for in this Order, he shall observe and execute all the lawful orders and directions of the sanitary authority and the Orders of the Local Government Board, which may be hereafter issued, applicable to his office.

Rules similar to the above have been issued by the Board of Supervision; but the English Public Health Act is of more recent date than the Scottish Act, and the rules are drawn up in accordance with the advanced knowledge of to-day.

We are now in a position, after having briefly described the general powers and duties of guardians of the public health, to enter into the subject of the special administration of the Public Health Act; and in doing so we will not follow the order of the Public Health (Scotland) Act, 1867, but arrange the sections and subsections in a manner that we hope will make the subject much more comprehensive and facilitate reference, as in the Act as it stands, sections bearing on special points will be found distributed through it, and thus are apt to be overlooked.

CHAPTER II.

REMOVAL OF NUISANCES.

In section XVI. are described certain conditions which are called nuisances under the Public Health (Scotland) Act, and it is our intention to enter fully into those important subjects,—to point out the ways by which these might be obviated or removed, and briefly to indicate the powers and duties which Local Authorities have to deal with those various conditions as they occur.

Before doing so, the word "nuisance" requires some explanation, as in law it has very different meanings. According to Guthrie Smith, in his *Digest of the Law of Scotland relating to Public Health* (3rd edition, p. 366), the word "nuisance" in law signifies anything which unlawfully annoys, offends, or does damage to another; and a nuisance is said to be either public or private. In England a public nuisance is punishable by indictment, but in Scotland is only removable by civil action. In the Sanitary Acts a nuisance has a more restricted meaning, being confined to those matters which are injurious to health. In a case in England, Mr. Justice Stephen gave an important decision as to nuisances. In this decision he ruled that a nuisance under the Public Health Act is anything which interferes with personal comfort, or is injurious to health. In the case of nuisances given in section XVI. it is not always necessary to lead proof that the thing complained of is dangerous to health, and in others it is sufficient that it may be dangerous to health. These instances will be specially mentioned as they occur.

Sect. XVI. subsect. (A). "*Any insufficicncy of size, defect of structure, defect of ventilation, want of repair or proper drainagc, or suitable water-closet or privy accommodation or cesspool, and any other matter or circumstance rendering any inhabited housc, building, premises, or part thercof, injurious to the health of the inmates, or unfit for human habitation or use.*"

The word "premises" occurring in this clause is defined in this Act, and includes "lands, buildings, structures of any kind, streams, lakes, drains, ditches, or places open, covered, or inclosed, and any ship lying in any sea, river, harbour, or other water, or *ex adverso* of any place within the limits of the Local Authority."

This clause is apparently very inclusive, and embraces every circumstance which renders a dwelling-house either unhealthy or unfit for use. Although not specially mentioned, schools doubtless would be considered as coming under this section; and most properly so, as any defect of structure, want of proper means of heating, lighting, or ventilation, require as much, if not more, care than defects in buildings used by adults, children being much more susceptible to injurious influences. The first defect mentioned in this clause which might be considered a nuisance is

Insufficiency of Size.

While no hard and fast line is laid down as to what minimum cubic space for each individual should be allowed, sanitarians are agreed that a very much greater cubic space is necessary than what is usually found. Insufficiency of space implies overcrowding, and overcrowding is a fertile cause of ill-health in various ways, besides favouring greatly the propagation of infectious diseases.

The question of cubic space is primarily one of cost, and, where rigid economy is demanded, space suffers.

The Royal Commission on Cubic Space in Workhouses considered that, where so many persons have to be lodged at the expense of ratepayers, the most rigid economy of space was demanded, and they fixed 300 cubic feet for dormitories in workhouses occupied only at night by people in health, provided that the wards did not contain more than two rows of beds, and that the height, if above 12 feet, was not reckoned in the calculation.

The Royal Commission on Barracks fixed the cubic space for soldiers occupying the room by day and night at 600 cubic feet per man.

The Glasgow Police Act gives power to regulate the occupation of houses of not more than three rooms, and not exceeding an aggregate capacity of 2,000 cubic feet, exclusive of lobbies and recesses. This is done by affixing tinplate tickets on the outer door, stating the cubic contents and the proportionate inmates

allowed, at the low rate of 300 cubic feet per adult, or two children under eight years.

Under the Public Health (Scotland) Act no such discretionary power of fixing a minimum air space is conferred, and what would be considered sufficiency might be a serious departure from what sanitarians would consider necessary. That there is no fixed minimum space is very much to be regretted, for from every point of view—social, moral, or sanitary—the evils of overcrowding, and life in the one-room house, are apparent. The evils arising from overcrowding, however, only concern us now in so far as they affect the public health, and they have been again and again commented on by the most eminent sanitarians; and as the subject is one of great importánce, I shall quote from some distinguished writers on this matter. Dr. Farr, in his classic work on "Vital Statistics," says that it is proved beyond doubt that if the population be the same in other respects, an increase of density implies an increase of mortality; and he gives five groups of cases, showing the varying mortality with density of population.

Where the population was 86 persons to 1 square mile, the mortality was 14, 15, or 16 per 1,000.

Where the population was 172 persons to 1 square mile, the mortality was 17, 18, or 19 per 1,000. Where the population was 255 to 1 square mile, the mortality was 20, 21, or 22 per 1,000. Where the population was 1,128 per 1 square mile, the mortality was 23, 24, or 25 per 1,000. Where the population was 3,399 persons to a square mile, the mortality was 26 per 1,000 and upwards.

Farr also pointed out, that wherever the population is dense, cholera was most fatal.

It must be taken into consideration, that those results given above refer specially to the overcrowding of a given square mile, rather than to the overcrowding of a house from insufficiency of size; but the effect is the same, whether in the house or over an acre of surface. But to give strict comparable results, I shall quote from the published writings of Dr. Russell, the distinguished Medical Officer of Health for Glasgow, on the "Ticketed Houses" of Glasgow,

In this paper Dr. Russell tells us that in 1885 the population of Glasgow was 543,295, and the number of deaths was

13,439; and the distribution of population and the deaths in inhabited houses were as follows:—

	Population.	Deaths.
1 Room,	134,728	3,636
2 Rooms,	243,691	6,325
3 do.,	86,956	1,747
4 do.,	32,742	581
5 do.,	38,647	434
Institutions,	6,531	427
Untraced,	...	289
Whole city,	543,295	13,439

Dr. Russell deduces from this,—

	Population.	Deaths.	
1 Room,	24·7	2·3	per cent. above due proportion.
2 Rooms,	44·7	2·3	" "
3 do.,	16·0	3·0	per cent. *below* due proportion.
4 do.,	9·1	1·8	" "
5 and upwards,	7·1	3·3	" "

Turning to the incidence of infectious diseases. Taking the death-rates in the largest houses as unity, the death-rate from zymotic diseases was 2 in medium-sized houses, and 4 in the smallest. From lung diseases, the death-rate was 2 in medium-sized houses, and 3 in the smallest.

An elaborate paper by Professor Carnelley and Drs. Anderson and Haldane appeared in the *Transactions* of the Royal Society for 1887, on "The Carbonic Acid Organic Matter and Micro-organisms in Air, more especially in Dwellings and Schools;" and by this paper we find, from an elaborate table, that as we pass from 4 roomed to 3, 2, and 1 roomed houses, not only does the air become more and more impure, but there is a corresponding and similar increase in the death-rate, together with a marked lowering of the mean age at death.

I have sufficiently quoted from the above eminent authorities to prove how intimately related are insufficiency of size of houses with disease and death; and to conclude this section I may be allowed to add, in Dr. Farr's words: "The nearer people live to each other, the shorter their lives are."

Defect of Structure.

Under this clause can be included all the possible defects that can be met with in the construction of houses, site, foundations, walls, roofs, doors, and windows; and to deal with these subjects in a satisfactory manner a whole treatise would be required; but at this time only the most apparent defects, such as would be considered dangerous to health, can be alluded to.

Site of Houses.—It is not usually the case that the site of a house is determined by purely sanitary reasons, many other important considerations entering into the decision; but, nevertheless, salubrity of site for all kinds of houses is of primary importance. There are two primary requisites for a suitable site for a house, viz., that it is so situated that water can be introduced by gravitation; and, secondly, that water can also be removed by gravitation. This latter condition implying, of course, free facility for drainage of the soil and the removal of sewerage matters. Very often, however, we find that whole villages have been erected without any consideration as to how these two important matters were to be effected, resulting often in most unsanitary conditions, both as to defective water supply and sewerage removal. The further consideration of water supply and sewerage falls to be considered under the clauses dealing specially with those subjects. In the selection of a site, special consideration must be given to the nature of the soil and the conformation of the ground. The term soil is used to denote all that portion of the earth's crust which can in any way affect health. Soils in composition are found to consist of various kinds of mineral, animal, and vegetable matter, besides holding in the pores air and water. The amount of these vary much in different soils, according to their combined physical and chemical conditions.

The chemical constituents of soils are very varied, and it would take us beyond the present scope to enter into the subject, and at this time we will discuss soils under the headings of—

1. Air in soils.
2. Water in soils.
3. Conformation of soils.
4. Mixed physical and chemical conditions.

Air in Soils.—To understand the nature of the air in soils it will be necessary to consider the composition of the atmosphere, which is as follows:—

Oxygen, . .	per 100 parts,	20·9
Nitrogen, . .	„	79·0
Carbonic Acid Gas,	„	·04
Watery vapour.		
Ozone.		
Ammonia.		
Various mineral, animal, and vegetable products.		

Now the atmosphere does not end with the earth's surface, but passes into it to varying depths and in varying quantities; and that portion met with in soils is called the ground-air. No soil is without this, even the hardest rocks containing it. Loose sands may have from 40 to 50 per cent., sandstones 20 to 40 per cent. In its chemical nature it varies very much, usually containing an excess of carbonic acid. Sometimes carburetted hydrogen (marsh gas) and sulphuretted hydrogen are found. Carbonic acid gas is a product of the decomposition of animal and vegetable substances, and an excessive amount in a soil should be viewed with suspicion.

The ground-air moves, rising and falling, under the influence of the temperature and pressure of the atmosphere above, with the rise and fall of the subsoil water, and by the action of winds. The practical application of the knowledge we possess regarding the chemical and physical conditions of ground-air consists in the fact that ground-air is very liable to emanate from soils and pass into houses built over them. This is easily understood when we know that by heating houses they acquire a higher temperature than the soil, upward currents are produced, and the ground-air rises and passes into houses; and if it happens to be polluted by the products of decomposing matters, by leakages from gas or sewerage pipes, most serious results may follow.

That ground-air can travel a considerable distance in a lateral direction has been proved, and one instance is mentioned in De Chaumont's *Lectures on State Medicine*, where gases from a cesspool travelled a distance of 27 feet and passed into a house.

A remarkable instance of coal gases passing into a house in such a quantity that a fire was put out by the carbonic acid, was

described by the writer in the *Sanitary Record* a year or two ago. The house was situated over disused coal-workings, and under certain conditions of atmospheric pressure gases were given off which sometimes escaped into this house, on several occasions putting out the fire.

In connection with polluted ground-air, and the consequent danger of its passing into houses, it will now be readily understood why a pure soil should be selected as a site for houses, and how dangers arise from building over what are called "made soils."

It often happens, to make up some unevenness of soil, or for filling up holes which have been caused by removal of sand or clay for their different purposes, carried soil has to be procured, and every kind of trade refuse, ashes, sweepings of streets, and, in fact, anything handy, are utilized. Under the action of heat and moisture the contained animal and vegetable matters in these made soils begin to decompose, gases are given off, which escape into the interior of any house built over them.

The town of Leicester is notorious for its high death-rate among infants and children, and this has been in part attributed to houses being built on refuse matters.

Drs. Parkes and Sanderson, in their report on the sanitary state of Liverpool, recommended that as the animal and vegetable matters in cinder refuse disappear in about three years, houses should not be built on such made soils under two years from the date of last deposit. They further recommended deep draining to keep those sites dry where excavations had been made.

Although these already mentioned are important examples of how ground-air may be polluted, there are many other ways which are in constant operation and of everyday experience. Every variety of animal or vegetable substance thrown on the surface of the soil soon begins to decompose and break down, the gases partly passing into the general atmosphere and partly into the soil, mixing there with the ground-air. Every faulty drain, cesspool, sewer, ashpit, allowing leakage to occur, in like manner pollute the ground-air; and if houses are situated near such, there is great danger of their being thus polluted. And we come across examples like these daily in country places,—faulty ashpits, sewers, and cesspools, and houses in such close proximity to them that pollution must occur. Slop water and the water which

has been used for washing clothing is only too frequently discharged over the soil; and however much we believe in irrigation, it is not at all desirable to have it in close proximity to dwelling-houses.

Having now pointed out a few ways in which the ground-air may be polluted, I shall now point out remedies which will obviate these risks, and the first one is almost self-evident, viz., do not put anything of a polluting nature into or over the soil near dwelling-houses; but we can only look for this at the sanitary millennium. The next and most practical method is to cover over the site of houses with some impermeable substance which will prevent the ground-air rising into houses. Concrete, cement, pavement, or asphalte, may be used for this purpose.

Water in Soils.—Just as all soils contain air, they contain water in varying quantities, according to the kind of soil, porosity, angle of slope, and other conditions. Water may amount to mere moisture, giving rise to dampness, or as a continuous sheet of water, called subsoil water. Subsoil water is of much importance, both as determining the relative degrees of dampness of soils, and also from the fact that wells and springs derive their supply from this. Subsoil water may be as low as 15 feet from the surface, which is considered sufficiently low to give a dry soil above; or it may be as high as only 5 feet from the surface, causing a damp soil.

Some soils hold a greater quantity of water in the pores than others; thus loose sand will hold two gallons in a cubic foot; sandstone, one gallon; chalk, 13 to 17 per cent.; clay, 20 per cent.; and humus, 40 to 60 per cent. The moisture of the soil is determined by the rainfall, evaporation, and percolation, and also greatly by the subsoil water, which is constantly changing, rising and falling at different seasons of the year. It usually begins to rise in December and continues till March, agreeing closely with the months of greatest rainfall and greatest percolation. The subsoil water also is always moving like an underground river, gravitating to the most dependent parts, where its outlet exists in some river or ravine. Its direction, of course, is influenced by the nature of the strata it passes through, by the "dip" of these, faults, etc. Moisture and subsoil water are of importance from a sanitary point of view, as they are associated in causing many diseases, such as rheumatism,

neuralgia, colds; and from the observations of Dr. Buchanan of the Local Government Board of England, and Dr. Bowditch of America, phthisis is known to be intimately related to dampness of soil; and the drying of soils in sanitary operations led to the diminution of this deadly disease in many districts.

In Salisbury, for instance, the death-rate from phthisis had fallen 49 per cent.; in Ely, 47; in Rugby, 43.

The conclusions that Dr. Buchanan came to were, that there was less phthisis among populations living on pervious soils than in populations on impervious; within the same counties there was less phthisis among populations on high-lying pervious than on low-lying pervious soils; and within the same counties there was less phthisis among populations living on sloping impervious soils than among populations living on flat impervious soils. The whole question resolving itself under the comparative dryness of the soil, and the consequent comparative infrequency of phthisis.

In this country, of course, we have not much experience of malarial fevers, though cases do occur now and again, and in the flat, wet districts of some parts of England ague is not uncommon; but not so many cases occur as formerly, from improved drainage.

Water in soil has been considered by the distinguished Pettenkoffer to be intimately associated with the occurrence of cholera and typhoid fever. Pettenkoffer holds that the following conditions are necessary:—

A rapid sinking of the subsoil water, after an unusual rise, the ground polluted by animal matter, heat of soil, and the entrance into the soil of a specific germ. A fall of the subsoil water after an unusual rise may act, and undoubtedly often does act, in quite a different way, by carrying impurities into wells and other sources of water supply. In the same way, when the level of the subsoil water is lowered by pumping wells, the direction of the flow of subsoil water may be altered, and impurities which previously ran from wells may run towards and directly into them. When we come to speak of water supply, the other important points regarding subsoil water will be described.

When we have a damp soil merely to deal with, ordinary draining, of course, is the remedy; but when we have to deal with a high subsoil water, then very deep drains must be con-

structed, so as to prevent the water rising above the depth of the deep drains. It may be necessary to improve the outfall of the subsoil waters in addition to deep draining. If there is high ground adjacent to the site of a house, a deep catchment drain should intervene to prevent water gravitating from this source. At the immediate site of houses, various precautions should be adopted in every well-constructed house, such as building the walls on a concrete foundation, or putting a layer of asphalte over the foundation, or by using specially prepared glazed tiles, such as Doulton's, Taylor's, and others. Any such "damp proof" course will usually be effectual in preventing damp rising into the walls. Another very necessary precaution is not to have any soil abutting against the walls, but to have an air area right round the house. When the soil is found as I describe it, higher than the foundation, it should be removed, and an open space built to allow free circulation of air. The methods just described have referred to the foundations, but it is also very useful to cover up the soil under the floors with some impervious course, after having removed the turf and vegetation from the surface. The walls under the floors should have perforated bricks or other openings at opposite sides, so that air may freely blow through. By the adoption of such means the dampest soils will be rendered harmless, and the houses drier, warmer, and in consequence healthier. All materials for the construction of walls are more or less porous, and absorb moisture, which by capillary attraction may rise 10 to 30 feet in the walls, causing dampness to appear on the plaster or paper. To keep these tolerably dry, extra fuel must be burnt, causing extra expense, as by the evaporation of water a great deal of heat is lost. A cubic foot of water evaporated will lower the temperature of three million cubic feet of air 1° Fahrenheit. It will be thus seen how important it is to have dry walls, even from no other consideration than the amount of cold produced by damp.

Conformation of Soils. — Under this heading fall to be considered the relative amount of plain and hill, the height of the latter, the angle and the direction of slope, and the position and direction of watercourses and valleys. The higher the situation above sea-level, usually the colder it is, as a fall of temperature of 1 degree occurs for every 300 feet we ascend, within certain limits. Evaporation goes on more freely

at high levels, and the earth radiates heat more freely, so that after sunset the temperature falls rapidly, while through the day the heat at high levels may be intense, owing to there being less moisture than at low levels, and the full heating effect of the sun's rays is experienced. The air at higher levels contains more ozone, and is freer from impurities. Malarial fevers are seldom met with at high levels, though the poison may be wafted up hills by winds blowing over marshes. It is not desirable to build a house at the bottom of a hill, from the likelihood of dampness, though it may be a healthy site if an intervening valley cuts off the hill, and if the ground slopes from the site of the house so as to facilitate drainage and circulation of air. If high ground is necessarily adjacent to a house, then the formation of a deep trench will go a far way to diminish the injurious influence of this.

A house built in a hollow is almost sure to be damp, even on a porous subsoil, as water from the surrounding high ground finds its way into such situations, and also damp, cold air gravitates, like every other thing, to the most dependent parts. Thus we often see mists hanging in the hollows when the high-lying ground is quite free from them.

The situation of hills in relation to the site of houses has also an important effect in sheltering them from certain winds. The judicious planting of trees may do much to break the action of winds, care being taken not to have trees so closely planted or so near houses as to prevent free circulation of the air. Besides, in autumn, when dead leaves are covering the ground, the air becomes polluted with their decomposing products, and a free circulation of air is needed to carry them away. It will be seen that "the fall of the leaf" has a good deal of scientific truth in it as regards unhealthiness. Trees have a further action in altering climates. Thus, according to Buchan in his *Handbook of Meteorology*, trees may be considered as reservoirs in which the heat of the day is stored up against the cold of the night. Changes of temperature take place very slowly in the tree, but in the air they are very rapid. Hence the effect of forests on the daily temperature is to make the nights warmer and the days colder. Evaporation goes on slowly from damp ground under trees. Forests diminish the summer temperature, and maintain the winter temperature higher than it would otherwise be.

Physical and Chemical Conditions of Soils.—The sun's rays falling on soils heat them to varying depths and degrees, according to their combined chemical and physical state. The daily changes of temperature do not affect the soil to greater depths than 3 feet. From observations made on the Calton Hill by the late Professor Forbes, it appears that the annual variation does not penetrate farther than 40 feet below the surface, and after 25 feet it is very small. The highest annual temperature in the trap rocks at Calton Hill, at a depth of 24 feet, takes place about 4th January, and the lowest about the 13th July, thus reversing the conditions of atmospheric temperature. For every 50 feet in depth, the mean increase of temperature over the globe is about 1° Fahrenheit.

While these are the general conditions of soil temperature, different soils have very different temperatures according to their power of conducting heat, and the conducting power for heat of soils has an important effect in producing a healthy site for houses.

The following soils are arranged in order, showing their relative power to retain heat. Sand being the worst conductor, becomes most heated, and is used as the standard:—

Sand, with some lime,	100·0	Clayey earth, .	60·4
Pure sand, . .	95·6	Pure clay, . .	66·7
Light clay, . .	76·9	Fine chalk, . .	61·8
Gypsum, . . .	73·2	Humus, . .	49·0
Heavy clay, . .	71·1		

It will be seen from this table how very cold a clay soil is in comparison with a sand one, and that other things being satisfactory, it is desirable to build a house on sand rather than on clay.

The researches of Professor Tyndall have shown that the heat which falls on water and on granite are not radiated back to the air equally, but much more passes back to the atmosphere through its aqueous vapour from the granite. The chemical composition of soils is much too extensive a subject to enter into now, and I have already mentioned that there are mineral, animal, and vegetable matters in all soils. From a sanitary point of view, the two latter are probably the chief, from their liability to decompose and give off noxious gases under the action of heat,

moisture, and minute organisms, variously called micro-organisms, germs, microbes: organic matter in its vegetable and animal forms being the food on which these minute plants live. Many diseases are due to microbes; and it will be remembered, in treating of subsoil water, it was stated Pettenkoffer considered that, in the production of cholera and typhoid, a specific germ was needed, as well as the other conditions he thought necessary. If we have a soil polluted with organic matter, especially human excreta, under favourable conditions of temperature and moisture the "germs" of cholera, typhoid, etc., on gaining entrance, will grow and multiply, and may gain admission into the human system in many ways.

Wherever human beings are crowded together, or even living together without being crowded, the soil gets polluted by all kinds of refuse. Animal and vegetable matters are poured into the soil; and when the quantity exceeds the purifying action of the soil, dangerous emanations as well as equally dangerous living organisms arise. Hence one of the chief duties of those whose function it is to guard the public health is, by all means, to prevent the pollution of the soil by animal or vegetable refuse matter. In concluding this section I shall quote Parkes' opinion regarding different soils as to their degree of suitability for sites for houses.

1. Granitic, Metamorphic, and Trap Rocks.—Sites on these formations are usually healthy; the slope is great; water runs off quickly; the air is comparatively dry.
2. Clay Slate.—These rocks resemble the granitic and granitoid in their effects on health.
3. Limestone and Magnesian Limestone Rocks.—These so far resemble the former.
4. Chalk.—The chalk, when unmixed with clay, and permeable, forms a very healthy soil.
5. The Sandstones.—The permeable sandstones are very healthy; both soil and air are dry. If the sand be mixed with much clay, or if the clay underlies a shallow sand-rock, the site is sometimes damp.
6. Gravels of any depth are always healthy, except when they are much below the ground surface, and water rises through them.

7. Sands.—These are both healthy and unhealthy. The healthy are pure sands which contain no organic matter, and are of considerable depth. The unhealthy sands are those which contain a vegetable sediment. In other cases, sands are unhealthy from underlying clay or laterite near the surface, or from being so placed that water rises through its permeable soil from higher levels. In another case sands are unhealthy from containing soluble mineral matter.
8. Clay, Dense Marls, and Alluvial Soils generally.—These are always regarded with suspicion.
9. Cultivated soils are often healthy.
10. Made soils are usually very unhealthy.

Defects of Walls, Roofs, Floors.

The materials used for the construction of walls are various, and the following are used :—bricks, stones, wood, concrete, iron, and in very inferior houses they may even be made of mud.

In a cold country such as ours the great consideration is to keep in heat and keep out cold, at least in many months of the year. The kind of material and the thickness of the walls determine how far those conditions obtain, and different materials differ widely in their conductivity for heat; and where we have a material which allows heat to pass through very freely, to counteract the loss of heat which results, we must have additional thickness of wall.

The following table from Galton's work on *Healthy Dwellings* shows, for different materials, the different units of heat which pass through equal thickness of material in equal times :—

Marble, grey, fine grained,	28
do. white, coarse grained,	22
Freestone,	13·68
Glass,	6·6
Brickwork,	4·83
Plaster,	3·86

Different materials have also varying degrees of density, determining their power for absorbing water and also for diffusing of gases through them.

Bricks will absorb from 2 to 22 per cent. of water.

Granite absorbs $\frac{1}{2}$ per cent.

Sandstone from 8 to 20.

From their power of taking up water, walls may be rendered very damp, with a consequent great loss of heat, even although every precaution is taken to prevent ground-damp rising. Where bricks are used for walls, they should be well burnt, hard, and tough; and porous bricks, at least for external walls, ought to be rejected. Compressed bricks are useful, as they do not absorb water to the same extent as ordinary bricks, and they look better. In brick walls it is a very good plan to leave a hollow space between an outer and an inner skin of bricks, the two being connected by bonding bricks or other ties. There is much less loss of heat through such walls, and damp is less likely to rise, or to pass through from the outside.

In some situations walls become damp from what is called "driving wet," that is, by the rain beating against the walls; and if the material in the latter is porous, a large quantity of water may be absorbed. Various devices are used to prevent this, such as painting or cementing the walls externally.

To prevent dampness getting into the walls from the top, the roof should have projecting eaves, or an impermeable course should be placed on the top of them.

The thickness of walls should be determined by their height and length, and as those are increased so should their thickness.

Roofs are constructed in this country of slate and tiles on wood, but in some parts thatch is still used; and however picturesque it is, there are objections to its use, such as danger of fire and the lodgment of vermin.

It is recommended by architects to lay slates with a 3-inch lap; and this is very important, for if less, snow and rain may be driven in. It is a good plan to lay slates on a layer of felt, as this substance is a bad conductor of heat, acting in the summer by keeping out the strong heat of the sun, and in winter keeping in the heat, which has to be economised as much as possible.

Rhones or gutters, for carrying away the rain-water which falls on the roof, should be provided for every house however humble; and the conductors which lead the water from these should never by any reason open directly into a sewer and thus

act as ventilators, but a trapped gully should intervene to prevent sewer-air rising into the conductors.

The reasons for this precaution are these. Conductors are often made of zinc, and on this material sewer-gases act and corrode into holes through which the gases leak, it may be near a window, and pass into the house; when they are made of iron the joints are not properly lead-caulked, but often are made of putty and such like materials, which dry up, crack, and allow leakage; and even although the joints are perfect, the conductor of course ends at the eaves, where the sewer-gas would escape and might thus easily pass into the house. Another important objection is, that during a heavy rainfall the conductors are running full, so that they could not act as sewer ventilators, at a time when it is most desirable to have free ventilation in the sewer, from the increased tension of the air contained in them, due to the increased volume of water flowing through.

In case of bursts, conductors should be fixed at about 3 inches distance from the walls.

Where it is desirable to save rain-water for domestic purposes, mechanical contrivances, called rain-water separators, are affixed, their use being to keep out impurities and to reject the first rain that falls and washes the roof. A good example of this apparatus is Roberts' Percolator.

Floors.—Floors are constructed of wood, pavement, concrete, fireclay or ordinary clay.

It is desirable in all rooms inhabited by people that wood should be used, as it is not so cold as other materials. Ordinary white wood is used, and not always seasoned, so that it soon cracks, or the joints open out. The objections to these are, that moisture and impurities lodge and decompose, and many floors are excessively foul from this reason. If it were not for the extra expense, some kind of hard wood should be used as being less absorptive. Instead of washing such floors, it would be much better to have them oiled and beeswaxed, and rubbed to a polish. To clean such floors, wiping with a damp cloth and then rubbing with a dry one would be sufficient. It is believed by some medical men that common causes of croup are the cold and damp from floors which have been washed; and, strange to say, cases of croup occur very often on a Saturday, the day of the week on which floors are washed in workmen's houses.

Whether croup is caused by this or not, there can be little doubt that a damp floor, soaked with animal or vegetable impurities, under the heat of the house may give rise to dangerous emanations.

Any matter relating to doors and windows will be better described under the subject of ventilation.

CHAPTER III.

VENTILATION.

The subject of ventilation is one which might have a treatise devoted to it, as it is one of the most important as well as one of the most difficult subjects which demand the attention of sanitarians and architects, and it cannot be said that they invariably solve the problem in its practical application in house construction.

Air is a necessity for life, greater than water or food. We can live a considerable time without the latter, but existence is measured by minutes, two or three, when the supply of air is cut off. When the purity of air is affected, the results, although slower, are as certain, and health invariably suffers. Yet it cannot be said that people are impressed with the urgent necessity which exists for pure air in abundant quantity in every inhabited house, whether it be church, school, workshop, or dwelling-house. Angus Smith says in his work on *Air and Rain*: "When we are children, air is to us as nothing; a vessel of air is a vessel with nothing in it. Instead of thinking it nothing, we are now inclined to go to the other extreme."

No one can possibly be impressed with the necessity for abundance of pure air without possessing some knowledge of its physiological action, and, very briefly, it may be stated that in the process of respiration a certain quantity of atmospheric air is introduced into the air-cells of the lungs, where it is brought into relation with the circulating blood. An interchange occurs, the blood throws off certain impurities which have been generated in the animal economy,—organic matter and carbonic acid along with moisture,—and in its turn absorbs a certain quantity of oxygen, which is absolutely necessary to carry on the various vital functions. If the air is deficient in oxygen, or polluted with other matters, as it too often is, then ill-health and even death ensue.

An intimate knowledge of some of the chemical and physical properties of air, it will be seen, is thus necessary to understand the subject of ventilation.

The chemistry of air has been studied by many distinguished observers, and as a result of their investigations we know that, with very little variation, pure air has per 100 vols. the following composition:—

Oxygen, . .	20·99
Nitrogen, .	79
Carbonic acid, .	·04
Ozone, . .	variable.
Vapour, . .	do.
Organic matter, Ammonia,	minute traces.
Suspended matter—	
a. Animal, *b.* Mineral, *c.* Vegetable	traces.

I have said, that with little variation the above shows the percentage composition of very pure air away from sources of pollution; but samples, which had been vitiated by any of the various causes, showed a different composition to considerable degrees, the alterations chiefly being the oxygen becoming less, carbonic acid, organic matter, and suspended matters being increased.

For example, the following samples of bad air were found by Angus Smith in mines:—

Oxygen.	Carbonic Acid.
19·94	·76
19·01	2·35
19·24	2·08

Analysis showing composition of Manchester air, and air from closet or midden behind laboratory:—

Air from Closet.	Air from Street.
Oxygen, 20·70	20·943

Air of London in tunnel, . . .	20·88
Air in sitting-room, . . .	20·89
Air in pit of theatre, . . .	20·65
Air in cow-house, . . .	20·70
Air in stables, . . .	20·74
Air from Scotland, . . .	**20·999**

It will be seen from the above examples how much the vital oxygen may vary in different places when sources of pollution are present, such as in mines, inhabited places, and wherever filth is to be found. In fact, all organic matter when undergoing decay or putrefaction robs air of its oxygen, and, as we will afterwards see, adds other vitiating products to it. In reference to these analyses, Angus Smith wrote: "Some people may inquire why we should give so much attention to such minute quantities, between 20·980 and 20·999. A little more or less oxygen might not affect us; but, supposing its place occupied by hurtful matter, we must not look on the amount as too small. Subtracting 0·980 from 0·999 we have a difference of 190 in a million."

We must further give to oxygen another important function in its power as a disinfectant, and this is another reason why we should endeavour to keep air in its natural purity; but if we rob it of its oxygen, we at the same time destroy nature's chief and great disinfectant. The various other conditions which lead to diminution of oxygen in air will be described farther on.

Nitrogen occurs in a constant quantity in air, and as its main use is to act as a diluent, without any other particular qualities, no further reference is needed to it.

Carbonic Acid.—A great deal of importance is placed on the amount of carbonic acid in air. Much more, indeed, than its own effects demand; but this arises from the fact that carbonic acid is used as a test and an indicator of the quality of air; an excess showing that air has become vitiated. The tests for determining the amount of carbonic acid are simple, hence many analyses have been made, and thus great importance has been given to it. It may, however, produce fatal results when present in excessive amounts, as from 5 to 10 per cent.; and when from 1·5 to 2 per cent., produces headache, languor, and discomfort.

Dr. Angus Smith's experiments led him to believe that 3 per

cent. produced feebleness of the circulation, with usually slowness of the heart's action, while respiration was quickened, and sometimes gasping. In soda-water manufactories, when 2 volumes per 1000 were present, the workmen were found to suffer no discomfort.

Dr. Smith found the following quantities:—

Average of 339 analyses in mines, .	·7850	per cent.
Largest amount in mines in Cornwall,	2·5000	„
In theatres, ...	·3200	„
About middens, ...	·0774	„
School-room, ...	·0970	„
In close buildings, ...	·1604	„

Results obtained by Professor Carnelley in Dundee:—

One-room house, ...	·112
Two rooms, ...	·099
Four, ...	·077
School, ...	·186

The examples given from Professor Carnelley's experiments are most important, bearing, as they do, so intimately on the question of ventilation, and show, that as people are aggregated together, vitiated air occurs proportionately. I have already shown that as people are crowded together, both sickness and mortality increase. The quantities of carbonic acid vary greatly according to various circumstances: thus there is more in the night than during the day, an increase in spring, a diminution in summer, and the highest amount occurs in autumn. It is increased by the breathing of all animals, by decay, and by the combustion of organic matter. It is taken up by plants during day, but is given off by them during night. In the process oxygen is set free. Plants in sleeping apartments are thus objectionable, during the night at any rate.

Ozone.—This gas is a variety of oxygen, possessing the properties of it, but in a much more active degree. Its object appears to be, to oxydise all noxious matters, and thus render them harmless. It is never found where there is excess of organic matter, as in the wards of hospitals, in overcrowded houses, or in the centre of cities. There is more at the seaside

than in the interior of a country; more on mountains than on plains.

It is used, by artificial preparation, as a disinfectant, from its powerful oxydising action.

Water Vapour.—This exists in air in various quantities, according to the temperature. As the temperature of air is raised, so is its capacity for holding water as vapour. The quantity which would saturate air at 50° F. would only give 71 per cent. at 60° F. Complete saturation being called 100, any percentage between that and zero is called relative humidity. This point can be found from the wet and dry bulb thermometers, by the use of specially prepared tables for this purpose. A relative humidity not exceeding 75 is desirable. The weight of a cubic foot of dry air at 32° F. and normal pressure is 566·85 grains, and the weight of a cubic foot of saturated air at 60° is 532·84 grains.

Organic Matter.—This important substance, from the reference so frequently made to it as an impurity of water as well as of air, demands a somewhat full description. Chemically, all organic matter consists of carbon, generally also hydrogen and oxygen, and frequently nitrogen. In the purest air it exists in only minute quantities; but where air has been vitiated by the respirations, excretions, and secretions of animals, and by fermentations and decompositions of organic matter, it increases, so that its presence may be perceived by its heavy offensive smell. It was suggested by the late Professor Chaumont to use the simple test of smell as an indicator of the amounts of organic matter present in different samples of air. The organic matter found in air is believed to be albuminous or nitrogenous.

The organic matter given off by respiration has a fœtid smell, and is believed to exist as very fine particles or molecules. It is dense, and hangs about a room, so that unless there are free currents of air passing through the room, it is difficult to displace. When drawn through solutions of permanganate of potash they become discoloured, and through pure water this becomes offensive. The walls of a room absorb organic matter, and considerable quantities can be got in the old plaster on walls. It clings to furniture, and careful washing and rubbing is necessary to remove it, and prevent its offensive smell becoming manifest.

Organic matter is of importance, from greater reasons than that of its offensive smell; as there is every reason to be-

lieve that diseases are actually caused by some of its forms, and we know definitely that air loaded with organic matter also has an excessive number of microbes present. All microbes are not dangerous, but a small percentage are, and these are the causes of deadly diseases. If we had no organic matter in air we would have no microbes, from the deprivation of the food necessary for their demands.

Ammonia exists in the air, as the carbonate, nitrate, nitrite, or chloride. It is derived from the decomposition of organic matter, and, along with what is called albuminoid ammonia, the quantity is used as a test for the amount of organic matter present. Ammonia is found in excess near gasworks, being derived from the manufacture of coal gas, and from this source is not attended with the same significance. Rain-water contains a large amount of ammonia from "washing" out impurities in the atmosphere, and thus it acts as a purifier.

Impurities in Air.

To treat this subject in detail is impossible, and here only certain general conditions can be discussed. The atmosphere is a highly-varying chemical compound. No two samples from different sources are probably similar, but vary according to the various causes which are constantly in operation, manufacturing the local atmospheres of a district. Every house has its special atmosphere, according to the number of its inmates, its means for getting rid of impurities, including its cleansing and ventilation. The air of every workshop has its peculiar atmosphere, according to the work carried on; and the air of each field varies from its neighbour, according to the nature of the soil, dampness, and other conditions. Impurities may be described under the sub-divisions—*a.* Suspended; *b.* Gaseous.

a. **Suspended matters** include animal and vegetable substances, and are extremely variable and extremely numerous, as will be seen by any one who watches the motes of a sunbeam streaming into a darkened room. The varieties are too numerous to describe, and only a few can be selected. In the air of dwelling-houses we find carbon particles, tarry matter, hairs, epithelium from the skin, linen, wool, and cotton fibres, and invariably microbes of various kinds. In rooms papered with wall-papers coloured by arsenic, this poison may be found.

In sick-rooms, in addition to the above, we have a large quantity of organic matter and various other impurities, according to the nature of the sickness.

In workshops we find steel, wood, sandstone, iron, copper, brass, cotton, wool, and silk particles, according to the occupation or trade carried on.

b. **Gaseous impurities** vary with the kinds of occupations and trades carried on. Thus in alkali works we have hydrochloric acid as an impurity; and in linoleum and floorcloth works we have the offensive smell of oils. From glue works, slaughter-houses, knackeries, we have organic vapours. From gasworks we have ammonia and sulphur compounds. From india-rubber works, carbon bisulphide.

Impurities due to certain Special Causes.

Impurities from Respiration and Transpiration. — The main alterations produced are the following: the oxygen is diminished, carbonic acid, organic matters, and moisture are increased, and temperature is raised.

Impurities from Combustion of Coal Gas.—From burning gas we have raised temperature, increased moisture; and nitrogen, carbonic acid, carbonic oxide, sulphur compounds, and ammonia are formed. One cubic foot of gas requires for complete combustion from ·9 to 1·64 cubic feet of oxygen, and produces 2 cubic feet of carbonic acid gas; or to put this in another form, 1 cubic foot of gas uses the oxygen of about 8 cubic feet of air, and raises the temperature of 31,290 cubic feet 1° F.

Impurities from combustion of—

Coal: carbon, carbonic acid, carbonic oxide, sulphur and ammonia compounds, water; and 1 lb. of coal requires 240 cubic feet of air for combustion.

Oil requires from 140 to 160 cubic feet of air for every pound.

Wood requires 120 cubic feet of air for combustion.

There are various other common sources of impurities more or less always present; thus the gases from sewers, drains, and cesspools, and other allied sources. Pollution of air and subsoil air by churchyards and vaults undoubtedly occurs where these are in the centre of populous places, as too often happens.

The various examples we have given of sources of pollution by

solid, animal and vegetable, and gaseous impurities, are selected from the many that occur, simply as they are common examples, and must be taken into consideration in every scheme which is intended to deal with the question of ventilation.

Before entering into the question of ventilation there are several points to be considered of great importance, and which have only been incidentally touched on. At the present time we are only dealing with inhabited houses, and we will very shortly recur to the factors which act in vitiating the air of such houses; and these mainly are respiration and transpiration, combustion of coal, gas, wood, and oil. By these various processes we saw air was deteriorated. And it has been found by experiment, the proof of which I cannot now enter into, that to keep those impurities within limit, and to keep the amount of moisture so as not to exceed a relative humidity of 75 per cent., a general average of 3000 cubic feet of air per head per hour is demanded. In a room of 1000 cubic feet the air would have to be renewed three times per hour, and in a room of 500 cubic feet, six times. If we diminish the cubic space we have to increase the times of renewal, and in practice it is found that three times in an hour is as much as can be borne in our climate, and with more frequent renewals the room becomes cold and draughty. We do not do away with the necessity for renewal of the air by increasing cubic space, as it is only a question of time to reach the limits of vitiation. The theoretical space of 1000 cubic feet is more than three times the amount which is allowed in the "ticketed houses" in Glasgow. And the amount allowed by the Barrack Commissioners is only 600 cubic feet; and very few houses even of the better class possess such an amount. But this condition of cubic space forms an essential point in the problem of ventilation.

In allotting cubic space, height of room must bear a relationship to floor space, and this must not be curtailed by undue height of room. In small rooms there should be a height of 10 feet; in very large rooms, from 15 to 20 feet.

In barracks the floor space varies from 50 to 80 superficial feet; in workhouses a minimum of 25 is allowed. Dormitories in schools should have a floor space of from 50 to 60 feet.

As to the size of outlets and inlets; from various considerations there should be for inlets an air space of 24 sq. inches, and the same for outlet, although theoretically the outlet should be larger

than the inlet, from the expansion of outgoing air by the heating it has undergone previous to its discharge.

Principles of Ventilation.

The object in ventilating a house, workshop, or mine, is to get rid of the impurities which invariably arise, as already described, and to substitute as pure air as can be obtained. There are thus two conditions implied in the word ventilation, viz. removal of impure, and substitution of pure air. Even in the worst constructed houses the process of ventilation is never entirely in abeyance, from the working of the ordinary laws of nature, apart from those set in operation by man's endeavours. The former are called natural means and the latter artificial, although they depend on the same laws.

Natural ventilation is caused by (1) diffusion of gases. This takes place but slowly, and depends on what is called the diffusive powers of gases, in virtue of which they mix with each other, although of different weights. Gases diffuse in virtue of this power through porous bodies, as through brick or stone walls. Experiments have shown that the rate of diffusion differs very greatly in different gases, and that the velocity of diffusion is inversely proportionate to the square roots of their densities. As a means of ventilation, this physical property of gases cannot be depended on.

(2) **Action of Winds.**—Wind is air in motion, and all winds are caused by changes of temperature. If two places have different temperatures, the air from the warmer region flows out, and the air from the colder flows in. The velocity varies greatly—from 100 miles per hour to 1 or less. In this country about 12 miles may be considered an average rate. In its progress it flows into our houses by every chink or keyhole, and even through the walls of houses; and by blowing over the tops of chimneys and ventilating shafts it produces an up-current usually, thus materially assisting ventilation. In practice many devices are used, depending upon the action of the wind, to produce up-currents. The great objection to this action of wind as a ventilating agent is its uncertainty.

(3) **Action produced by Heat.**—This depends on the same cause as winds, viz. different densities of bodies of air produced by different temperatures. In the process of heating rooms, by

whatever means, and by the heat radiated from our bodies, the air becomes warmer, expands and rises, escaping by the openings sometimes provided to facilitate this, or by any opening. Colder and hence heavier air rushes in to supply its place, and thus a constant circulation is produced.

The amount of air which can be introduced in this manner will depend on the size of inlets and outlets, if any such are provided. Where a room has a chimney, of course that acts as an outlet, and the amount of air passing through it will depend on sectional area, height of chimney, and difference between its temperature and that of the external air, with some deductions for friction, which may be from $\frac{1}{4}$ to $\frac{1}{3}$ of the total amount.

By an ordinary chimney, as much as from 35,000 to 40,000 cubic feet of air can be discharged per hour. The practice of closing up chimneys in summer, when not in ordinary use, cuts off a most important channel for removal of air from houses.

Artificial Ventilation.

The systems included under this resolve themselves into two distinct varieties: one in which air is drawn out—the Vacuum method; and the other in which air is forced in—the Plenum method.

Of the vacuum method, the most ordinary example is the open fireplace and chimney, up which a current of air passes, in consequence of the air becoming heated, and therefore becoming lighter than the external air. Outside air flows in by all openings to supply the place of the outgoing air. This method has, however, been already referred to. The action of heat is also taken advantage of in the same manner where steam-pipes are used for heating. And some systems of lighting not only provide for the removal of the products of combustion, but also take advantage of the heating effect, of burning gas to produce an upward current through a shaft provided for the purpose. Schonheyder's sanitary stove is an illustration of this method, and Boyle's system of warm-air inlet ventilators is another, as also is the sun burner.

Extraction by means of a fan or screw is another most important system of ventilation, but not usually applied to the problem of house ventilation.

Fans are most commonly used on the propulsion method; the motive power may be hand power, steam or gas engines, or water power.

Fans are used almost invariably in ventilating mines, and enormous quantities of air can either be withdrawn or forced in, according to the kind of fan used. Some schools are ventilated in this manner also, and without doubt this system is the best of all artificial methods. And churches would frequently be much better ventilated buildings if fans were used instead of the various defective systems usually adopted.

Devices used for Ventilating Houses.

Having given a brief description of pure air and the ways in which it becomes impure, and of the general principles connected with ventilation, it remains now to describe a selected few out of the many devices which are launched on the public as solutions of the problem of ventilation. The problem of ventilation is associated with the heating of houses; and stoves and grates are often specially designed to meet both difficulties, and these will be described farther on.

The action of chimneys has been frequently referred to, and so no further necessity exists for discussing this excellent ventilating method.

Windows.—These are not invariably so constructed as to permit of ventilation by them; but no house should be constructed without providing for this. The top sash should be made to pull down, and the lower one to push up; and to facilitate these, they should be counterpoised by weights. The top of the window should reach near to the ceiling, and the size of the window should be about 1 square foot for every 100 cubic feet of space of room. Where possible, there should be a window at opposite sides of a room, to allow free perflation of air.

The following adaptations are used to assist the action of windows, and to diffuse the air into the rooms:—

(*a*) By having the windows so constructed that the top slopes inward when opened.

(*b*) By having perforated or louvered panes, or having some of the panes double, with an opening at the top of one pane and an opening at the bottom of the other.

(*c*) By raising the lower sash of an ordinary window, and

inserting a piece of wood about 3 inches broad to fill up the space caused by raising the lower sash, a current of air can then pass between the bars of the upper and lower sash.

(*d*) By fixing to top of window a gauze screen, which unfolds when the window is pulled down.

(*e*) By cutting out a slip of wood from the lower bar of upper sash, along its whole length, and about $\frac{1}{4}$ inch in thickness.

(*f*) By having a part of a pane to open or shut at will by a spring arrangement.

Outlets and Inlets.—One of the best forms of inlets is the Sherringham ventilator. It consists of an iron air-brick or box inserted close to the ceiling of the room, and opening to the external air. At the mouth of the opening into the room is a hopper-shaped valve, hinged at the bottom, and opening upwards. It can be opened or shut by means of a cord.

Instead of this arrangement, perforated bricks may be inserted at the top of the wall, as in barracks.

Tobin's Tubes.—The air is introduced from the outside through a horizontal tube leading to a vertical one, rising about 4 ft. on the inside wall. The air is thus diffused over the room, and sometimes this is a means of introducing cross ventilation when there are no windows on opposite sides of the room. There are various modifications of this plan, such as air brackets fixed on to the wall, and leading to the external air; Boyle's brackets being examples. Inlet tubes may be placed at the floor level, when there are means for heating the ingoing air, otherwise it would be too cold. The tubes should be kept thoroughly clean, and protected by a grating outside, to keep out cats, etc.

Potts' System.—A hollow metal cornice runs round the room, divided longitudinally in its whole length into two separate channels by a plate attached to the lower one. The fresh air is admitted through openings in the wall to the lower channel. The upper channel communicates with the smoke flue or other air shaft. The incoming air being denser, falls into the room; while the inside air being lighter, ascends and escapes through the upper channel.

Varley's System.—A perforated metallic tube runs round three sides of the room, communicating with the external air; while on the fourth side another perforated tube communicates with the chimney, and acts as an extraction shaft.

Some forms of inlet ventilators, such as those supplied by the Sanitary Engineering and Ventilating Company, provide means for filtering the ingoing air, to remove from it suspended impurities. In their method the air is strained through woollen cloth. Cotton wool may be used for the same purpose, or copper wire gauze. The Æolus Water-Spray and Ventilating Company pass the ingoing air over a spray of water.

M'Kinnel's Ventilator consists of two tubes, one within the other, but of the same sectional area. The inner tube projects above and below the outer, and acts as outlet, while the outer acts as inlet. The inner tube has a flange at its lower end, so that the air descending the outer, impinges against this, and is deflected over the room.

Watson's Tube is square, with a partition dividing it into two, one side being higher than the other.

Mure's Tube resembles this last one, but is divided into four compartments, and has a louvred box at the top.

The current is apt to be reversed in all these tubes, an inlet becomes an outlet, and *vice versa.* Many varieties of ventilators are provided with cowls or louvres; and all depend on the action of the wind, unless means are taken to produce an upward current by heat; but when there is no wind blowing, they prevent a down current.

Boyle's air-pump ventilator is highly recommended, and acts with a very light wind; and his ridge ventilators are very useful for schools and churches.

Ventilators combined with Heating.

One of the best forms of grates for this double object is Galton's. Fresh air is admitted at the back of the grate, where it is moderately warmed by a large heating surface, and then carried by a flue adjacent to the chimney into the upper part of the room.

George's Calorigen is a stove which draws the air necessary for combustion from the outside. A spiral tube passes through the fire, by which warmed air is introduced into the room. Stoves made of cast iron are to be avoided, as it is found that carbonic oxide, a very poisonous gas, passes through them. Wrought iron, or stoves lined with fireclay, prevent this occurring.

Schonheyder's sanitary stove is a good form. Boyle's warm-air inlet ventilators act most efficiently, and a brief description of

their application to the ventilation of the London Guildhall will be useful.

The air is extracted from the ceiling by means of Boyle's ventilating cowls. Fresh air is supplied in the following manner: —On the south side of the chamber four vertical air tubes or brackets are fixed against the wall, 2 feet by $2\frac{1}{2}$ inches by 3 feet in size; the other two, placed a little higher up in the wall, measure 1 foot 6 inches by 4 inches by 2 feet. The tubes communicate directly with the outer atmosphere by holes in the wall, and are covered with cast-iron gratings. The inlets are provided with Boyle's heaters, by which the ingoing air is warmed. The north wall is similarly treated, with the addition of an extra tube at the end by the Lord Mayor's seat. Three more inlets are provided at the public end of the building, while others, amounting to sixteen, are in all provided; an abundant supply of air is admitted by these tubes, and the air can be warmed in cold weather to a temperature of from 60° F. to 120° F. The products of combustion are prevented by a special arrangement from entering the building.

Previous to Messrs. Boyle's attempts, the Guildhall was very badly ventilated, but now it has received the almost universal approval of experts for satisfactory ventilation.

General Considerations as to Inlets and Outlets.

No system of ventilation, in its true meaning, can be adequate which does not provide for the removal of vitiated air as well as for the introduction of pure air; and as regards inlets, the greatest care should be taken to keep them clean, and to see that the source of air is not polluted. When wind is blowing strongly against one side of a house where there are inlets, too much air may enter, and the room become cold; so that inlets should have provision made for closing them partly. Inlets and outlets should be arranged so as not to draw through each other without changing the air of the room to be ventilated. Gratings and gauze coverings, and cotton or wool filters, should be periodically examined and cleaned, as they soon become clogged up and foul.

Hygienic Importance of Ventilation.

In the section devoted to insufficiency of size of houses, it has been shown how strongly Dr. Farr pointed out that density of

population and mortality are intimately related, and that as overcrowding occurs, so does increased mortality. Dr. Russell also points out this in dealing with the vital statistics of Glasgow; and Prof. Carnelley and Drs. Haldane and Anderson, in their valuable paper already referred to, point out this in connection with experimental investigations on the air of overcrowded places. The Health of Towns Commission Reports and the Barracks Commission Reports long ago brought out the same thing as strongly. Phthisis, at one time so prevalent in the army, has been reduced considerably by improved ventilation in barracks. Such diseases as hospital gangrene and pyæmia break out in hospitals where amongst other conditions there is defective ventilation. In the treatment of all diseases, especially if infectious, an abundant supply of pure air is needed, and there is no better disinfectant.

Typhus fever is intimately associated in its occurrence with deficient ventilation, and there is every reason to believe that it might be stamped out entirely by removal of the causes leading to bad ventilation.

Sanitary Examination of Rooms.

It is impossible to enter fully into the subject of the full chemical and physical examination of air, as this can only be dealt with in a special treatise, but a short *résumé* may be found useful; for further details, the works of Parkes, Smith, Fox, and others must be consulted.

Cubic Space.—This, of course, is obtained by the ordinary rules of mensuration; but as these cannot always be borne in one's mind, the following data will be found useful and available for all shapes of rooms. Where a room is very irregular, it is necessary to make various measurements of triangles, squares, domes, etc., and to add the total measurements to get the sum.

To obtain the cubic capacity of a—

Square room, × length, breadth, and height together.

Area of circle $= D^2 \times - {}\cdot7854$.

Circumference of circle $= D \times 3\cdot1416$.

Diameter of circle $= C \div 3\cdot1416$.

Area of ellipses = product of two diameters × ·7854.

Area of rectangle. Multiply two sides perpendicular to each other.

Area of triangle. Base × $\frac{1}{2}$ height.

Area of parallelogram = two triangles.

Area of segment of circle = $(\text{Ch} \times \text{H} \times \frac{2}{3}) \times \frac{\text{H}_3}{2 \text{ Ch.}}$

Cubic capacity of a cube. Multiply the three dimensions.

Cubic capacity of solid triangle = area of triangle × depth.

Cubic capacity of a cone. Area of base (see circles) × $\frac{1}{3}$ height ($D^2 \times \cdot 7854 \times \frac{1}{3}$ H).

Cubic capacity of a dome = $D^2 \times \cdot 7854 \times \frac{2}{3}$ height.

Cubic capacity of a sphere = $D^3 \times \cdot 5236$.

By the application of these measurements the size of the most irregularly shaped room may be ascertained. To obtain the available air space, however, deductions are necessary for furniture and space occupied by individuals.

For bedstead and bedding, deduct 10 cubic feet.

For each person, deduct 3 cubic feet.

Examination of Air Inlets and Outlets.—Note situation, kind and area of each, and the velocity of air passing through them, and also through the room. This can be best determined by the use of an anemometer, such as Casella's, which is used thus:—Being set at zero, it is placed in the air current; if in a shaft, not in the centre, but about $\frac{1}{3}$ from side. The time is noted by a watch for one minute, and the air movement is indicated by the dial. The linear discharge multiplied by area gives volume of air passing per minute.

Temperature and Moisture.—These are most conveniently got by the use of the wet and dry bulb thermometer. This instrument should be in the room for a considerable length of time before readings are made, and should be so placed as to get a fair average reading.

By the readings from this apparatus we ascertain the actual temperature of the room, the dew-point, and relative humidity. The last two observations require calculations. The dew-point is found thus: read the temperatures of the wet and dry bulbs, note the difference, multiply this by factor in Glaisher's tables opposite temperature of dry bulb, and the result is the dew-point.

To get the relative humidity, Glaisher also supplied tables, which are used thus: the difference between wet and dry bulb temperatures supplies a number which represents the relative humidity. As this is an important observation, a table is supplied for determining this.

TABLE OF THE RELATIVE HUMIDITY GIVEN BY THE DIFFERENCE BETWEEN THE DRY AND WET BULB.

Temperature of the Dry Bulb.	Difference between the Dry and Wet Bulb.															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Relative Humidity, Saturation = 100.															
90	100	95	90	85	81	77	73	69	65	62	59	56	53	50	47	44
89	100	95	90	85	81	77	73	69	65	61	58	55	52	49	46	43
88	100	95	90	85	81	77	73	69	65	61	58	55	52	49	46	43
87	100	95	90	85	81	77	73	69	65	61	58	55	52	49	46	43
86	100	95	90	85	80	76	72	68	64	61	58	55	52	49	46	43
85	100	95	90	85	80	76	72	68	64	61	58	55	52	49	46	43
84	100	95	90	85	80	76	72	68	64	60	57	54	51	48	45	43
83	100	95	90	85	80	76	72	68	64	60	57	54	51	48	45	42
82	100	95	90	85	80	76	72	68	64	60	57	54	51	48	45	42
81	100	95	90	85	80	76	72	68	64	60	56	53	50	47	44	41
80	100	95	90	85	80	75	71	67	63	59	56	53	50	47	44	41
79	100	95	90	85	80	75	71	67	63	59	56	53	50	47	44	41
78	100	94	89	84	79	75	71	67	63	59	56	53	50	47	44	41
77	100	94	89	84	79	75	71	67	63	59	56	53	50	47	44	41
76	100	94	89	84	79	75	71	67	63	59	55	52	49	46	43	40
75	100	94	89	84	79	74	70	66	62	58	55	52	49	46	43	40
74	100	94	89	84	79	74	70	66	62	58	55	52	48	45	43	40
73	100	94	89	84	79	74	70	66	62	58	54	51	48	45	42	40
72	100	94	89	84	79	74	69	65	61	57	54	51	48	45	42	39
71	100	94	88	83	78	73	69	65	61	57	53	50	47	44	41	38
70	100	94	88	83	78	73	69	65	61	57	53	50	47	44	41	38
69	100	94	88	83	78	73	68	64	60	56	53	50	47	44	41	38
68	100	94	88	83	78	73	68	64	60	56	52	49	46	43	40	37
67	100	94	88	83	78	73	68	64	60	56	52	49	46	43	40	37
66	100	94	88	83	78	73	68	64	60	56	52	48	45	42	40	37
65	100	94	88	83	78	73	68	63	59	55	51	48	45	42	39	36
64	100	94	88	82	77	72	67	63	59	55	51	48	45	42	39	36
63	100	94	88	82	77	72	67	63	59	55	51	47	44	41	38	35
62	100	94	88	82	77	72	67	62	58	55	50	47	44	41	38	35
61	100	94	88	82	77	72	67	62	58	54	50	47	44	41	38	35
60	100	94	88	82	76	71	66	62	58	54	50	46	43	40	37	34
59	100	94	88	82	76	71	66	61	57	53	49	46	43	40	37	34
58	100	93	87	81	76	71	66	61	57	53	49	46	43	40	37	34
57	100	93	87	81	75	70	65	61	57	53	49	45	42	39	36	33
56	100	93	87	81	75	70	65	60	56	52	48	44	41	38	35	32
55	100	93	87	81	75	70	65	60	56	52	48	44	41	38	35	32
54	100	93	86	80	74	69	64	59	55	51	47	43	40	37	34	31
53	100	93	86	80	74	69	64	59	55	51	47	43	39	36	33	30
52	100	93	86	80	74	69	64	59	54	50	46	42	39	36	33	30
51	100	93	86	80	74	68	63	58	54	50	46	42	38	35	32	29
50	100	93	86	80	74	68	63	58	53	49	45	41	37	34	31	29
49	100	93	86	79	73	67	62	57	53	49	45	41	37	34	31	28
48	100	93	86	79	73	67	62	57	52	48	44	40	36	33	30	
47	100	93	86	79	73	67	61	56	51	47	43	39	36	33	30	
46	100	93	86	79	73	67	61	56	51	47	43	39	35	32	29	
45	100	92	85	78	72	66	60	55	50	46	42	38	34	31	28	
44	100	92	84	78	71	65	59	54	49	45	41	37	34	31	28	
43	100	92	84	78	71	65	59	54	49	45	41	37	34	31	28	
42	100	92	84	78	71	64	60	54	49	44	40	36	34	30	27	
41	100	92	84	77	70	64	58	53	48	43	39	35	31	28		
40	100	92	84	77	69	63	57	51	46	42	38	34	31			
39	100	92	84	77	69	63	57	52	47	42	38	34				
38	100	91	83	75	68	62	56	50	45	41	37					
37	100	91	83	75	68	61	55	49	44	39						
36	100	91	82	74	66	59	53	47	42							
35	100	90	80	72												
34	100	89	79	72												
33	100	89	78	70												
32	100	87	75													

Estimation of Carbonic Acid.—This may be done by various methods, but the best is Pettenkoffer's. The essential process is washing a measured quantity of air with a certain quantity of standard lime-water or baryta water, and noting the loss of causticity due to the absorption of carbonic acid.

For the whole process the following apparatus and chemicals are needed:—

1. Glass bottle with wide mouth, fitted with india-rubber plug; for collecting sample of air.
2. Bellows, with india-rubber tube, long enough to reach the bottom of glass bottle.
3. Burette graduated into cubic centimetres.
4. Turmeric papers, glass rod, earthenware dish.
5. Standard solutions of lime-water and oxalic acid.

Standard oxalic acid solution is made by dissolving 2·25 grammes of crystallized oxalic acid in one litre of distilled water.

The causticity of the lime-water is determined by the oxalic acid solution, and for this purpose the oxalic acid solution is poured into the burette up to the top of the graduation, and 30 c.c. of lime-water are run into the earthenware capsule, or any other suitable dish. The oxalic acid solution is then cautiously run into the lime-water, and carefully mixed till a point is reached when no stain is produced on the turmeric paper, when the latter is touched with the point of a glass rod which has been dipped into the lime-water. At first the stain is dark brown, but becomes gradually paler with each addition of oxalic acid till there is no discolouration. This point indicates neutralization of the lime-water, and the number of cubic centimetres of oxalic acid solution used = causticity of lime-water; usually this is from 30 to 40.

To collect a Sample of Air for Analysis.—Into the bottle (previously accurately measured to cubic centimetres) the air is pumped by means of the bellows with the tube attached to the nozzle. This pumping must continue sufficiently long, to insure that all the air contained in the bottle has been substituted by the sample to be tested. Another, and perhaps better way, is to aspirate the air out; and in this case the india-rubber plug should have two holes, one with a tube reaching to the bottom, and connected with the aspirator. The holes after the operation can

be plugged with wooden pegs. After filling, in whatever way, the india-rubber plug is re-inserted and firmly tied down, as india-rubber has a tendency to become loose. The sample can then be taken to the room for analysis; and for this purpose 60 c.c. of lime-water are introduced into the sample bottle, this is shaken so as to wash the air thoroughly, then it is allowed to stand for six or eight hours, after which the causticity of the lime-water contained is again determined. For this operation 30 c.c. are measured out (it would hardly be possible to get out all the 60 formerly introduced), and the causticity determined in the manner already described.

Calculations are then made to get the amount of Co^2 per 1000 volumes. The following simplification will be found useful. Multiply the difference between the causticity of the lime-water before and after it has been placed in the jar by ·790, and divide the sum by the number of cubic centimetres contained by the jar, minus 60. The result is the ratio of Co^2 per 1000 vols. Corrections must then be made for temperature and pressure. For every degree above 32° F. add 0·2 per cent., and deduct the same for every degree below 32° F.

Example of whole process:—

Sample bottle had capacity of 1060 c.c.

Into this was introduced 60 c.c. lime, displacing equal volume of air, so that only 1000 c.c. were acted on. Observed temperature 40° F.

First causticity = 40
Second do. = 30

Difference = 10

Multiply by factor ·790 = 7·9 Co^2 per 1000 vols. Correction for temperature, 8° F. above 32° F. $0{\cdot}2 \times 8 = 1{\cdot}6$ per cent. to be added to the result,

or $7{\cdot}9 \times 1{\cdot}1016 = 8{\cdot}02$ per 1,000 vols.

Unless the place of observation is much above sea-level, the calculation for barometric pressure may be omitted.

The process is much simpler in actual practice than it appears in a description, and a little practice gives the operator considerable dexterity in its performance.

Estimation of Organic Impurities.—There are many methods used for this purpose, but I can speak from practical experience

of the method used by Professor Carnelley, and having found it to be a very useful adaptation of the permanganate of potash method, give it here.

Professor Carnelley's Method for determining Organic Matter.—The principle is reduction of potassium permanganate. The amount is determined colorometrically by comparison with a standard. The solution of permanganate used is of $\frac{N}{1,000}$ strength, of which 1 c.c. = 0·008 milligrammes of oxygen = 0·0000056 litre of oxygen at 0° and 760 mm. It is usually kept $\frac{N}{10}$ strength, and diluted as required, about 50 c.c. of dilute sulphuric acid being added to each litre of weak solution. The samples of air are collected in well-stoppered jars of about 3·5 litres capacity. The jars are filled by pumping out the air contained by bellows, and allowing the air to be examined to flow in. 0·50 c.c. of standard permanganate are then run into the jar, which is then tightly stoppered and well shaken for at least five minutes. 25 c.c. of the permanganate are then withdrawn by a pipette, and then placed in a glass cylinder holding about 250 c.c. Then 25 c.c. of the standard permanganate are run into a similar cylinder; both are diluted with distilled water up to about 150 c.c., and allowed to stand for ten minutes, after which the tints of the cylinders are compared. Standard solution is then run into the decolorised solution from a graduated burette, until the tints of both cylinders are of the same intensity. The amount of solution added from the burette is a measure of the bleaching effected by the known volume of air on half the permanganate. This multiplied by 2 gives the amount. The results may either be expressed in terms of the number of c.c. of the $\frac{N}{1,000}$ bleached by one litre of air, or by the number of volumes of oxygen required to oxidise the organic matter in, say 1,000,000 volumes of air. Example:—25 c.c. of solution from a 3·5 litre jar, in which 50 c.c. had been used, required 3 c.c. of the permanganate to bring it up to the standard, or the whole 50 c.c. would have required $3 \times 2 = 6$ c.c. This represents the number of c.c. of standard permanganate bleached by 3,500—50 c.c. = 3,450 c.c. of

air, consequently $\frac{6}{3 \cdot 45} = 1 \cdot 74$ c.c. is the bleaching effected by one litre of air. But 1 c.c. of $KMN0_4 = 0 \cdot 0000056$ litre of oxygen; $\therefore$ 1·74 c.c. $KMN0_4 = 0 \cdot 0000056 \times 1 \cdot 74 = 0 \cdot 0000097$ litre of oxygen is required to oxidize the organic matter in 1 litre of air, or 9·7 vols. of oxygen to oxidize the organic matter in 1,000,000 vols. of air.

The method is highly ingenious, and can be rapidly performed. Some difficulty is experienced at first in matching the tints, and with some samples of mine air no amount of standard would bring the decolorised sample up to its colour. For the purposes to which Professor Carnelley applied this method, it has many things to recommend it; but for the air of mines, those objections to which the permanganate method is liable render the test unsatisfactory as a test for organic matter; but as a test for organic matter and other impurities coexisting, it is a most useful test. In mines we have those various substances existing which, as well as organic matter, decolorise the permanganate solution, such as sulphuretted hydrogen, nitrous acid, sulphurous acid, etc., from the combustion of gunpowder, dynamite, and burning of lamps. The results I obtained were very high in many cases, but this I attribute to the presence of these compounds, as well as to the organic matter. Professor Carnelley refers specially to the effect of oil lamps; and in mines where many hundreds are burning during work, it is no surprise that my results are high, even from this cause alone. In Carnelley's experiments he found, before burning of lamps, oxygen needed per 1,000,000 vols. to be 8·7, while after, it had risen to 18·1.

Estimation of Ammonia. — This can be done by drawing a measured quantity of air by means of an aspirator through a series of bottles containing perfectly ammonia-free distilled water. The greatest care must be taken to have perfectly pure distilled water, and also that the bottles, stoppers, connections, etc., are carefully cleansed by rinsing out first with hydrochloric acid and then with pure distilled water. The estimation of the ammonia and albuminoid ammonia is performed in the same way as in the process of water analysis, and the quantity of these should be expressed in milligrammes per cubic metre, or in grains per cubic feet.

Advantage may be taken of the air-washing which takes place

in the above process to examine the water for suspended matters, micro-organisms, etc., derived from the air.

Nitrous and nitric acids may be determined from air-washings in the manner described for the detection of these substances in drinking water.

In addition to the various chemical and physical methods for determining the degrees of impurities in air there is a test which can always be applied, and which has been found by experiment to have a certain amount of scientific accuracy. The test is by the sense of smell, and the indications given by this test on the one hand, and by chemical means on the other, were made the subject of experiment by the late Professor Chaumont, and these were found to have a distinct relationship. In recording the sensations experienced by the sense of smell the following expressions were used:—

Fresh and fair, indicated no appreciable difference from outer air.

Rather close, smell of organic matter appreciable.

Close, when smell became disagreeable.

Very close, extremely close, when smell was offensive and oppressive.

The results arrived at were, that when there was excess of Co^2 over that of outer air to ·1830 per 1,000 vols., the air gave no appreciable indication of organic matter. When "rather close" was experienced, or the smell of organic matter was distinct, the excess of Co^2 was ·3894.

When "close" was the sensation, the excess was ·6322; and when it was "extremely close," the smell being then offensive, the excess was ·8533.

In making observations by the sense of smell, the observer should pass directly from the open air into the room to be examined.

Method for Estimation of Micro-organisms.—The method of Hesse is by far the best in present use, and this was the one used by me. Koch's own method is useful so far, but the results are not quantitative. When specimens are only desired, and not an idea of the number for a given volume of air, Koch's method is useful, as also is the method of simply exposing plates with nutrient jelly, or sterilized potatoes, bread, etc., to the air to be examined.

Hesse's Apparatus.—This consists of a glass cylinder about 18 inches long and $\frac{1}{2}$ inch in diameter. Over one end a piece of india-rubber sheeting is stretched and firmly bound round the end of the glass cylinder to prevent air sucking past it. The other end of the glass cylinder is closed with a tight-fitting plug of india-rubber, through which a glass tube passes. From this tube passes a piece of india-rubber tubing to a litre bottle filled with water, and from this bottle to a second litre bottle another tube passes; when not in action, this tube is pinched off. Along the bottom of the glass cylinder are 50 c.c. of nutrient jelly. The cylinder rests on a tripod stand similar to those used by photographers. The nutrient jelly, india-rubber caps, tubing, cylinder, etc., are sterilized in the usual manner by steaming in a sterilizer repeatedly, and the tubes with their layers of jelly are kept sufficiently long before using to see that there is nothing growing on them. When we wish to operate, the india-rubber sheeting is perforated by a heated needle or pin making a very small hole, and the pinchcock is screwed slack; water passes slowly from the upper to the lower bottle, and when it is empty a litre of air has been supposed to pass into the cylinder, and to deposit its contained microbes. As many litres of water as desired can be run out simply by reversing the position of the bottles. When the air is very foul one litre will be sufficient, as the colonies otherwise would be too close and run into each other. When the operation is over, sterilized india-rubber caps or pieces of cotton-wool, also sterilized, are bound over the ends of the Hesse tube, and it is then placed in an incubation chamber or other suitable place. After a week or ten days the colonies may be counted. At one time the glass cylinders were used with a coating of jelly all round the interior, but this is difficult to obtain, and in practice it is found that the microbes gravitate and settle on to the layer on the bottom of the tubes. The method of Hesse is very elegant, and has many advantages; from the length of the surface of the jelly exposed, separate colonies form, often giving pure cultivations, and their growth can be studied as on a glass plate, and inoculations can readily be made in the usual manner.

Even although we cannot say that in every case a specific disease is caused by defective ventilation, still a condition of health below normal is invariably produced, and there is in consequence

an increased susceptibility to various diseases, such as the class called tuberculous or scrofulous, as ordinary examples.

Powers of Local Authorities under Subsections dealing with Ventilation and Cleanliness of Inhabited Houses.

At section XLIV. of the Act it is stated that the Local Authority of a burgh or populous place of 1,000 inhabitants can make, with the consent of the Board, regulations for fixing the number of persons who may occupy a house, or part of a house, let in lodgings, or occupied by members of more than one family. They also, under this subsection, have the power to see that ventilation is provided in the common passages and staircases. Besides those points dealing with ventilation, they have full powers to regulate such houses so that they are kept clean and provided with necessary privy or water-closet accommodation.

Section XLV. deals with those dwellings which, being partly or in whole below the level of the surrounding ground, are called cellar-dwellings. Those dwellings must have a window of not less than 9 superficial feet clear of the frame, and a fireplace with a chimney or flue. If it is an inner or back room in connection with a front one, it must have a ventilating flue. The various rules applied to cellar-dwellings seem only to be applicable to those built subsequent to the passing of this Act (1867). Those dwellings must also be provided with a drain, the upper part of which is at least 1 foot below the level of the floor. They must also be provided with a water-closet, ashpit, or privy.

The owners of such places can be prohibited from letting them as dwelling-houses when they are defective in any of the ways described in this section.

In Part V. section LIX. the Local Authority have certain powers in connection with common lodging-houses. By a common lodging-house is meant a house or part thereof where lodgers are housed at a sum not exceeding fourpence per night for each person, payable nightly or weekly, but under a fortnight, or where a house is licensed to lodge more than twelve persons. Amongst other things, the Local Authority can make rules for their cleansing, ventilation, and fixing the number of lodgers. Rules in which

300 cubic feet were considered sufficient cubic space for each adult person have been passed by the Board.

The powers of Local Authorities to deal with the other matters relating to common lodging-houses will be treated in their proper section.

CHAPTER IV.

DEFECTS OF HOUSES DUE TO WANT OF REPAIR AND PROPER DRAINAGE.

The conditions coming under this heading have been, to a great extent, referred to already, and require no further attention, except that it is well to note that want of drainage is considered a breach of the Public Health Act.

Water-closet, Privy Accommodation, or Cesspool.

By a subsequent section (XIX.) of the Act it appears that Local Authorities have the power to insist on some such accommodation being provided by the owner of a house for the use of its inhabitants,—also for schools and factories ; houses occupied by lodgers, and underground dwellings, must have the use of W.C.'s. They also have the power to deal with them when in an unsatisfactory state.

What is a suitable water-closet is capable of being answered in different ways, and many varieties are in use which are not considered suitable by sanitarians. One of the commonest is the now old pan closet, with its filthy receiver below, and a most faulty trap arrangement. It will, perhaps, not be inappropriate to refer to the points which are considered essential for the satisfactory working of water-closets, and to the varieties meeting those requirements. In private houses, and where money is no object, the best article in the market can be got, and it will be found to answer well ; but in the houses of the working-classes, cheap kinds are got, very faulty, and do not meet with the requirements I am about to specify. One essential condition for a water-closet for the working-classes is, that the construction is simple, so that it does not go out of order easily. It should be flushed with a minimum supply of water, and should be inodorous. There is no greater benefit to any house than a closet which

meets those requirements, and there is no more dangerous nuisance than a defective one.

Varieties of Water-closet:—

a. Pan Closet. This consists of a china basin, in which a certain quantity of water is retained by a metal pan; underneath this is a large receptacle called the receiver, in which the pan works when the handle is pulled. The outlet of the receiver is provided with a D trap.

The receiver through course of time becomes coated with foul matter, and gives off foul gases, which accumulate in the empty space of the receiver, the consequence being that, when the handle is pulled and the pan falls, gases escape into the room in which the W.C. is placed. The D trap is also defective.

b. Valve Closet. Consists of a stoneware or china basin; but the outlet, instead of having a "pan," has a valve, which retains water in the basin. This valve opens into a small box below instead of the large receiver of the pan variety. The outlet should have a siphon or other good trap, such as an anti-D. With a liberal supply of water these closets act very well. An overflow pipe from the basin is necessary to guard against flooding; but care should be taken that this pipe does not become untrapped, from the suction action, when the valve is opened. This may be prevented by the overflow being made to discharge into the open air, or into some pipe disconnected from the soil-pipes.

c. Hopper Closet. Consists of a deep inverted stoneware cone, connected at the outlet by a siphon trap.

This kind has the following advantages: it is simple, cheap, inodorous, and allows matters to be discharged at once. It is essential to use with this kind of closet a water waste-preventer.

d. Wash-out Closets. In these the basin is so arranged that a quantity of water is always retained in it. An opening at the side allows a gush of water to flush out the contents into the siphon trap.

An abundant supply of water is needed, and this should be delivered from a water waste-preventer.

e. Plug Closet. In this variety a plug is used to dam up water in the basin instead of a pan or valve. A form made by Messrs. Jennings receives high praise in Latham's *Sanitary Engineering*; but I have been told by plumbers that it does not act well.

A good closet, meeting all the requirements, could be got from the following selection :—Shanks' Patent, Carmichael's Wash-down, Doulton's and Tyford's " Unitas."

Situation of Water-closets.

Whenever possible, the room should be on an external wall ; and better still, if it is built in tower style, cut off from the house by a passage with double doors, with a window in each side of the passage for cross ventilation. Where it is not possible to secure such special conditions as to the situation, lighting, and ventilation of water-closets,—and these should be as efficient as in any room of a house,—it should be an essential condition that the water-closet should not be in the middle of the house, but on an external wall, and both lighted and ventilated by a window, or, better, by two windows ; and in those cases where there is only one, a Sheringham valve or M'Kinnell's tubes would be a useful addition.

Precautions as to Water-closets.

It should be imperative that the water-closet is not flushed by a pipe leading direct from the house supply pipe or main, from the danger of impurities being thus introduced into the domestic water supply. Nor should the same cistern be used to supply water both for domestic purposes and for the water-closet, unless a water waste-preventer or other cistern intervenes for the use of the water-closet. The cistern used for supplying water for domestic purposes should not be situated in the roof above the water-closet ; the danger in this case being, that sewer-gas might gain admission into the household water supply. The overflow pipe from any cistern for water for household purposes should not lead into any soil pipe, or into the water-closet basin, but should be discharged outside, and used as a warning pipe.

The common plan for supplying closets with water is to place a spindle valve on a service-box in a cistern, the service-box being provided with an air pipe, for the escape of air when the valve guarding the entrance into the pipe leading to the closet basin is raised. There is danger of sewer-gas passing up this pipe into the service-box, up through the air pipe, and being discharged over the water in the cistern.

To obviate this a valve is sometimes placed under the seat,

called a "regulator" valve, and by it this supply pipe is always kept full of water, unless the cistern runs dry.

By the use, however, of a special cistern for the water-closet, either of the water waste-preventing or intercepting kind, all danger of household water being fouled is removed.

Connection between Water-closet and Soil Pipe.

From the water-closet to the external soil pipe a 4-inch lead pipe is usually provided. Buchan recommends a $4\frac{1}{2}$-inch pipe where there is a large flush of water to be discharged. This lead pipe has a siphon bend on it, and should weigh 7 lbs. to the square foot, and be drawn, not soldered.

This pipe should join the external soil pipe—usually made of iron—outside, as there is danger of a joint between iron and lead giving way, a galvanic action being set up, and the consequent escape of sewer-gas. The siphon bend should have a pipe, 1 to 2 in. in diameter, carried from the outside crown of the bend into the ventilating pipe, which should lead from the top of the soil pipe and be carried up full bore above the rigging of the house. Complete disconnection must be made between house drain and sewer pipe, as will be afterwards described.

Application of Water-closets, and Causes of Failure.

Experience, the greatest test of all, has shown that the water-closet system fails in poor neighbourhoods, in schools, railway stations, or generally wherever a large number of people have to be accommodated, and this from no fault of a properly-executed system, but from insufficient supervision, from gross carelessness, and wanton destruction of the parts of the system.

Where a satisfactory working of the water-closet system is to be expected, we must have an intelligent conception on the part of the users of what a W.C. is supposed to do,—not to expect it to act, as it often is made, as a common receptacle for all refuse ; besides, there must be efficient supervision made by some one, to secure the necessary conditions for success being carried out. Some distinct arrangement should invariably be made by which a recognised person should be responsible for the proper working of the arrangement,—either some one in authority, or the persons using the W.C. If this is left to no one in particular, then no one is responsible, and no one moves in the matter. Failure of the

water-closet system, from the various causes mentioned, has led to the adoption of a modification of its arrangements, especially for poorer neighbourhoods, schools, etc.; such are trough closets, tumbler closets, and latrines.

A Trough Closet consists of a long trough placed below and behind the seats of a series of closets. At one end it communicates with a drain, the opening into this being closed by a plug connected with an iron rod, by which it can be raised or lowered. Behind the back wall of the water-closet is a small chamber into which the scavenger alone has access. The plug is lifted from this by the scavenger, who comes daily for the purpose. The contents of the trough are discharged into the sewer, the trough is flushed out by a hose, the plug replaced, and fresh water run into the trough.

The closets are cleaned by the users in rotation, and an inspector calls every two or three days to see that it is done. This system has been found to act well. Another form of closet is what is called the tumbler closet. In this a basin is made to act automatically and discharge a quantity of water to flush out the trough.

Trough closets should be fitted with an automatic flushing tank, as Field's, and by the use of such the system has been greatly improved. Latrines, with self-flushing apparatus, made by Wilcox & Co., of Leeds, are strongly recommended. The closets are made of strong earthenware, salt glazed inside and outside. The only part not stoneware is the pitch-pine seat. The flushing apparatus is of two kinds :—

1*st*. An automatic arrangement by which the closets are thoroughly flushed out as desired.

2*nd*. Flushing by an arrangement under charge of attendant alone. The flushing cisterns can be had to hold from 5 gallons of water up to 140 gallons, the latter size being used where the closet has 20 seats. The price for one seat is £2, 15s., and for 20 seats is £35.

Privy Accommodation or Cesspool.

While the law demands that some such accommodation as water-closets be provided, it does not restrict this to any of the forms already described, but the service may be by privy or cesspool. The name cesspool is capable of different interpreta-

tions; but in this case it seems to apply to a form of accommodation—unfortunately too often seen—where the structure used performs the duties of a privy, ashpit, and general receptacle for every variety of refuse matter. A privy is usually a most primitive erection, as well as a great nuisance. Often made of wood, it may be seen stuck up in a garden like a sentry-box, happily if well away from the house, but too often in close proximity. The excretal matter is allowed to fall to the ground, and accumulates till the place beneath the seat can contain no more, and then it is removed in a stinking and offensive form. Sometimes privies are built of stone or brick, and the floor paved, as well as the ground under the seat. In these cases there is less soakage into the ground, and thus less risk; but no means are used to keep the excretal matter from fermenting.

In other cases the privy and ashpit are combined, leading to complete failure of what each should perform, and becoming most offensive nuisances.

Regarding these arrangements, Sir John Simon in his Public Health Reports says: "What nuisance this system at present constitutes in innumerable populous places, including some of our largest towns, can hardly be conceived by persons who do not know it in operation; and the infective pollutions of air and water supply, which it occasions to an immense extent in towns and villages throughout the country, are chief means of spreading in such places some of the most fatal of filth diseases." But as privies are admissible, it behoves us to describe how these may be so constructed and managed as to cause the least nuisance possible.

The most primitive form may be much improved by making the floor impermeable by a concrete or pavement floor, even if only under the seat; sloping the sides under the seat; and diminishing its size. This latter condition implies more frequent removal of contents. Two forms of privies, used respectively in Hull and Glasgow, deserve notice, as they have been found successful in practice.

The Hull middenstead consists solely of the space under the seat, and its floor is formed by a flagstone, which slopes downwards to the back wall at the ground level there. Ashes are thrown in through the hole in the seat, and the front board is movable to

allow the scavenger access to remove the contents, which is done weekly.

In the Glasgow form the space under the seat is smaller than in the Hull form, but it slopes back farther, so that the ashes are thrown in from the back. Several families use one privy, and the contents are removed every second day.

When the privy is combined with a cesspit or ashpit, the following conditions are necessary :—The place should be roofed in, to keep out rain, as *dryness* is essential to the proper working of such arrangements. It has been found that connecting them by a drain with sewers has led to the silting up of the latter. To provide ventilation, a shaft should lead up through the roof; and a door sufficiently large for clearing out the contents, as well as for throwing ashes in, is necessary. The pit should not be below the level of the soil, and should be rendered water-tight by cement. If the pit is not too large, and is frequently cleared out, the system of privy and ashpit in combination will be shorn of many of its evils. But when everything has been said in favour of privies and ashpits, even in their most approved forms, they are not so satisfactory as a well-conducted water-carriage system, and as they *conserve* refuse matters for a certain length of time their principle is bad.

A good variety of ash-closet is Morrell's, in which there is an arrangement by which the ashes are thrown through an opening in the side or rear wall of the privy on to a sloping board, which conducts them to a screener. By pressure on the seat, when it is being used, a quantity of fine ash is distributed over the excreta, the cinders pass over the screen, and are collected into a pail for fuel.

There are various other plans in operation which do not demand more than mention, but which with proper supervision are found to work well; such as the pail system, without any further preparation: pails, with deodorants and antiseptics; lined pails (Goux); pails in which ashes, house refuse, and excrement are deposited; pails into which ashes are screened over the excrement.

The Dry Earth System.

This, from the success of the system when properly managed, requires special notice, as it is of undoubted advantage when

applied to schools, camps, workshops, and even to small villages. For using inside a house it does not offer much inducement, as, however well it may be managed, the removal of the excretal matters, even when deodorised by earth, becomes offensive. There are various modifications of Moule's, the originator's system, but they all depend on the deodorant action of earth, which, by a mechanical arrangement in the apparatus, is distributed over the excreta each time the closet is used. The quantity of dry earth needed each time the closet is used is $1\frac{1}{2}$ lbs., but a quantity should be placed in the pail before actually using it. Different kinds of soil have different degrees of deodorant action, and the suitability of various soils is given in the following order:—(1) Rich garden mould; (2) peaty soils; (3) black cotton soils; (4) clays; (5) stiff clayey loams; (6) red ferruginous loams; (7) sandy loams; (8) sands.

The system does not provide for the removal of slops and other waste matters, and in this is defective. Careful isolation of the closets is as necessary as for W.C.'s, and preferably they should be outside altogether. Storage is requisite for drying and keeping the soil needed, and this is not convenient in towns. In all of the various conservancy methods of treating excreta, the great question of its removal and subsequent treatment remains a most difficult problem; but this subject will be referred to in the section dealing with accumulations of offensive matters (XVI. (D)).

Duties of Local Authorities in regard to Accommodation Arrangements.

It has already been pointed out that Local Authorities have power to insist on some form or other being provided, but latitude is given as regards the particular variety to be allowed; and over-laxity at the present time is shown to what in all forms are, unless most carefully attended to, dangerous and offensive nuisances.

A class of diseases has been fully dealt with in Sir John Simon's Public Health Reports, called filth diseases, and which have been found to be of extensive prevalence in England; and if we had any information on the subject, it would, in all probability, be found that Scotland was not behind England in this direction. Diseases included under this unsavoury designation embrace such fatal diseases as cholera, typhoid fever, diarrhœa,

dysentery, diphtheria; and along with this important list there are various others equally important, which, if not invariably caused by filth, are unmistakably aggravated by its presence; such are the various other forms of zymotic diseases. Besides those specific diseases, the breathing of air tainted with the emanations from putrid matter, the contamination of food and water supplies, when not actually leading to any of the above diseases, lead to a condition of low vitality in which the person is liable to be attacked by any disease to which the human body is prone. There is reason for believing that there is a variety of inflammation of the lung called filth - pneumonia; and it has been abundantly proved that pulmonary consumption is induced by breathing polluted air. Ulcerated and inflamed sore throats are common examples of diseases caused by sewer-air.

The remedy—to reduce such an appalling amount of strictly preventable diseases so far as associated with accommodation systems — is cleanliness, and this can only be obtained by the strictest attention to the construction and supervision of all forms of water-closets, privies, and cesspools.

In section XLI. it is stated that a Local Authority may erect public water-closets, privies, and urinals, and defray the expense of so doing, keep them in good repair, and cause them to be cleaned daily. By same section, and as already stated, a Local Authority may, by written notice to the owner or occupier of any school-house, or factory, or building in which more than ten persons are employed at one time in any manufacture, trade, or business, cause them or either of them to construct a sufficient number of water-closets or privies for the separate use of each sex, under a penalty not exceeding £20 for non-compliance with such notice.

Notice by Local Authority to construct Water-Closets or Privies.

The Local Authority of hereby give notice to you [*name and designation, and add:* owner (*or* occupier) of a school-house at , or of a factory or building situated at , in which more than ten persons are employed at one time in the manufacture of , etc.], and require you [to construct water-closets or privies for the separate use of male persons therein employed, and water-closets or privies for the separate use of the female persons therein employed, etc.], and that within from the service of this notice, all in terms of and

under the penalties specified in § 41 of the Public Health (Scotland) Act, 1867.

This notice served on the day of .

, *Sanitary Inspector.*

CERTIFICATE OF SERVICE.

I certify that I served a notice, of which the foregoing is a copy, on , therein mentioned, on the day of , at o'clock .M., by [*state mode of service*], in presence of the undersigned witness, viz.,

, *witness.*

Other Matters and Circumstances rendering a House unhealthy.

This clause is general in its application, and in consequence vague, but seems to include any conditions whatsoever which render a house unfit for human habitation or injurious to health, and which would have to be dealt with just as they occurred. There are, however, certain conditions of house construction, not specially referred to in the section, which includes this clause, and which are considered as highly objectionable and dangerous to health. These are met within what are known as back-to-back houses, which, with the exception of the end houses of a block, have only one external wall, the consequence being that sunlight and air are only admitted from the outside by one wall, and therefore the rooms are badly lighted and badly ventilated. Sunlight rarely penetrates into such rooms, and the wind can only flow over one side. By the diffusive powers of gases, air which may have been vitiated passes through the " party " walls from one house to another. Back-to-back houses imply overcrowding of people within a certain area. In a paper on " Tubercular Infective Areas " by Dr. Ransome, it was stated that tubercular diseases occurred more frequently in back-to-back houses; and a most elaborate report to the Local Government Board by Dr. Barry and Mr. Gordon Smith on back-to-back houses, brought out that such houses were considered by medical officers of health to be unhealthy.

There are various other matters of house construction and arrangement which Local Authorities have no power to deal with, at least in rural districts, but which are of much importance; and amongst them may be mentioned building houses in hollow squares, so that the wind cannot freely blow through

them; streets and courts made into *cul-de-sacs*; streets made too narrow, and with high houses, so that the sun and the wind are blocked out. There should be a fixed limit for the width of the street, and the height of houses should bear a certain proportion to this. No houses should be permitted with fixed windows, and cellar dwellings should be disallowed altogether.

Powers of Local Authority in Clause XVI. Subsection A. (summarised).

1. When the Local Authority or sanitary inspector believes a nuisance exists, admission may be demanded for themselves, superintendent of police, medical officer, or any other person or persons, to inspect such premises, at any hour between 9 A.M. and 6 P.M., or at any hour the operations suspected to cause the nuisance are usually carried on.

2. If admission is refused, the Local Authority or sanitary inspector may apply to the sheriff, magistrate, or justice of peace having jurisdiction in the place, stating on oath such belief. These may grant an order in writing, requiring the owner or occupier of the premises to admit persons above named.

3. If such occupier or person still refuse, he is liable to a fine of £5.

The magistrates above named, on being satisfied of refusal of entry, may grant warrant for forcible entry; and if no occupier or person can be discovered, or no person is found on the premises, the Local Authority, or their officers, may enter forcibly, if need be.

The following forms are recommended for the various procedures described:—

No. 1.—*Petition for Order to admit Local Authority and others, with Procedure, under sect.* 17.

Unto [*sheriff, magistrate, or justice*] the petition of sanitary inspector[1] of the district of ,

Humbly sheweth,—

That the petitioner verily believes, on reasonable grounds, that within or near the following premises, situated within the said district, viz. [*describe the premises; see* sect. 3, voce *Premises*], there exists a nuisance within the meaning of the Public Health (Scotland) Act, 1867, viz. [*state the nuisance, in terms of* sect. 16; *as*, That the said premises are so overcrowded while work is carried on therein as to be dangerous or injurious to the health of those

[1] This petition may run in name of the Local Authority.

employed therein; or other nuisance; or any other nuisance not specifically mentioned in that section]. That the petitioner, on at o'clock .M., demanded admission for himself [*here may be inserted the Local Authority; also the medical officer, the superintendent of police, etc., naming them; see sect.* 17] to inspect the same, but admission was refused. Wherefore this application is made under sect. 17 of the said Act, for admittance to inspect the premises this day, or any of the next days, at any hour between nine in the morning and six in the evening, and at any time betwixt the hours of and , during which period the petitioner believes that the operations suspected to cause the nuisance are in progress, or are usually carried on; or at such other times as may seem fit; and the petitioner therefore

Prays for an order in writing requiring the occupier or person having the custody of the aforesaid premises to admit the Local Authority of the said district and the petitioner [*state others* ut supra, *if wished*] at the times foresaid, or such other times as may be fit; and, in case of opposition, to find the opposing party liable in expenses.

According to justice, etc.

DEPOSITION OF THE AFORESAID PETITIONER.

At , the day of , in presence of , compeared the said , petitioner, who, being solemnly sworn, depones that the whole statements in the foregoing petition are true.

[*Signature of deponent and judge.*]

WARRANT FOR INTIMATION.

[The order, etc., *infra*, may be granted with or without intimation, sect. 17.]

[*Place and date.*]

Appoints a copy of the foregoing petition and deposition, and of this deliverance, to be served on the owner, or occupier, or person in charge of the premises therein mentioned, and appoints appearances to be made by him or them before the undersigned at on at o'clock .M. [*state so many hours or days*], previous service being made.

CERTIFICATE OF SERVICE.[1]

I, , hereby certify that on , at o'clock .M., I served a copy of the foregoing petition, deposition, and

[1] Service may be made by any person, sect. 110.

deliverance upon [*state the person or persons on whom service is made, and the mode of service (see sect.* 110), *and whether owner, occupier, or in charge*], all in presence of , witness hereto subscribing.

, *witness.*

ORDER FOR ADMITTANCE.

[*Place and date.*]

I, [*sheriff, magistrate, or justice*], having considered the foresaid petition and deposition, hereby, in terms of sect. 17 of the aforesaid Act, ordain and require the occupier or person having the custody of the aforesaid premises, to admit the Local Authority and sanitary inspector foresaid [*state if others*] to the said premises, for the purpose of inspecting the same, and that on this present day, or any of the next days, at any hour between nine in the morning and six in the evening, and also between the hours of and .[1]

CERTIFICATE OF FAILURE OR REFUSAL TO GIVE ADMITTANCE.

I, , hereby give notice that on the at o'clock .M., I demanded admittance, in terms of the foregoing order, but admittance was refused and withheld.

WARRANT FOR IMMEDIATE FORCIBLE ENTRY.

I, [*sheriff, magistrate, or justice*], being satisfied of the failure or refusal to give admittance, in terms of the foregoing order, hereby grant warrant to the said Local Authority and sanitary inspector [*here insert any others*] or any of them, for immediate forcible entry into the foresaid premises.

In section XVIII. it is stated, that where the existence of a nuisance is ascertained to their satisfaction by the Local Authority, or is certified in writing by the medical officer, or where the nuisance in the opinion of the Local Authority did exist at the time when demand for admission was made, or the certificate was given, and although the same may have been since removed or discontinued, is in their opinion likely to recur or to be repeated, they may apply to the sheriff, or to any magistrate or justice, by summary petition in any manner hereinafter decided (sect. 105 *et seq.*).

The Local Authority may be satisfied of existence of a nuisance—

1. By own inspection or other evidence.

[1] Expenses may be found due in case of opposition.

2. By certificate of medical officer.
3. In special cases, to be afterwards mentioned, by medical certificate or requisition in writing, signed by ten inhabitants of the district of the Local Authority.

Form of Medical Certificate of Existence of Nuisance.

CERTIFICATE BY THE MEDICAL OFFICER OF THE DISTRICT OF .

[*Place and date.*]

I hereby declare on soul and conscience, to the Local Authority of the aforesaid district, that within or near the following premises, situated within the said district [*describe the premises*], there exists a nuisance within the meaning of the Public Health (Scotland) Act, 1867, viz. [*state the nuisance*].

(Signed)

The certificate of medical officer may be used in all cases.

The Sanitary Inspector's Petition to accompany above Medical Certificate.

Unto [*sheriff, magistrate, or justice*], the petition of sanitary inspector of the district of ,

Humbly sheweth,—

That within or near the following premises, situated within the said district [*describe premises*], there exists a nuisance, within the meaning of sections 16 and 17 of the Public Health (Scotland) Act, 1867, viz. [*state the nuisance*]. That the author of said nuisance is [*state author, and whether owner or occupier, or both*].

If application is made on medical certificate dated , or on requisition by ten inhabitants, the certificate or requisition should be produced.

In case of suspected discontinuance of the nuisance, and of its probable recurrence, it may be set forth: That if the said nuisance is now discontinued it is likely to recur or be repeated, and the same existed on , when a medical certificate thereof was granted, or when a demand for admission to the premises was made on behalf of the Local Authority.

The petitioner therefore prays your [Lordship *or* Honours] to ordain service of this petition, and the deliverance thereon, on the said , and thereafter to ordain [him *or* them] to remove or discontinue the nuisance, and

for that purpose to [*state any special order*]; *add if desired:* and to prohibit and interdict [him *or* them] from, etc., in time to come.

According to justice.

[*Signature of petitioner or agent.*]

Service may be made by any person, and as in the form already shown.

For full details of interlocutor, reference may be made to section XIX., which gives full power for dealing with all nuisances under the Act.

According to section XXI., where structural works are required for the removal or remedy of a nuisance, the justice, magistrate, or sheriff may appoint such works to be carried out under the direction and subject to the approval of any person he may appoint; and he may order the Local Authority within a specified time to furnish him with an estimate of the cost of such works.

Section XXII. In case of non-compliance with, or infringement of, such decree as above, on application by the Local Authority, the sheriff, justice, or magistrate may grant warrant to any one he chooses to enter premises to which the decree relates, and carry out what is necessary for which decree was granted. If the author of the nuisance cannot be found, or is not known, the decree may at once order the Local Authority to execute the works; and all expenses incurred by the Local Authority in executing the works may be recovered from the author of the nuisance or the owner of the premises.

NOTE.—Under this section Local Authorities MUST remove nuisances.

Penalties for Contravention of Decree and of Interdict.

Subsection A.—Penalty of not more than ten shillings per day during his failure to comply.

If said interdict be knowingly infringed by the act or authority of the owner or occupier, such owner or occupier shall be liable for every such offence to a penalty not exceeding twenty shillings per day during such infringement.

CHAPTER V.

(SECT. XVI.—SUBSECT. B.)

Drains and Sewers.

Sect. XVI. subsect. (B). "*Any pool, watercourse, ditch, gutter, drain, sewer, privy, urinal, cesspool or ashpit so foul as to be injurious to health, or any well or other water supply used as a beverage or in the preparation of human food, the water of which is so tainted with impurities, or otherwise unwholesome, as to be injurious to the health of persons using it, or calculated to promote or aggravate epidemic disease.*"

Pools.—The term pool has no special meaning in sanitary nomenclature, and here it seems to refer to the collection of foul water in any hollow space in the ground. Very frequently a natural or made depression in the ground becomes the receptacle of all sorts of filth, from its being used as a cesspool, or simply from water gravitating and carrying polluted matter with it. The remedy is to put a drain through the excavation or depression, then fill it up, so that water will not accumulate. In my own experience I have seen such "pools" give rise to repeated cases of typhoid fever, and by adopting the above-mentioned remedy there was no recurrence of this disease.

Watercourses and Ditches.—These may be classed together, and are often great nuisances, from their being used as outlets for the discharge of sewerage pipes, ashpits, or pig-styes. It appears that a Local Authority can compel Road Trustees to carry off water when it is a nuisance, and now that the administration of roads and sanitary affairs is under one authority, such evils will be removed with less difficulty than formerly.

It need hardly be said that no watercourse or ditch should be fouled in the manner above mentioned; but when they are found to be so, a Local Authority has the power to order, subject

to the approval of the Board of Supervision, a sewer to be laid down (see sect. XXIV.). By the provisions of the Rivers Pollution Act, it is an offence to pollute watercourses, and the administration of this Act under the Local Government (Scotland) Act, 1889, is put into the hands of County Councils, so that such nuisances can be readily dealt with.

Gutters.—These are drains on the surface, either at the sides of roads, streets, or in front of houses; and frequently are very insanitary from defective construction. To be safe means of carrying off water, whether clean or foul, they should have sufficient gradient to allow their contents to run freely; and to prevent soakage into the ground, the joints should be close, and made with cement. The gutter should discharge into a trapped gully every 50 yards or so. Gutters may be made of dressed whinstone blocks, or of glazed fireclay; and either of those answers well if the joints are made close and laid in cement. Usually, however, undressed, irregularly-laid whinstone "bullets" are used for gutters, and stagnation occurs, as well as soakage into the soil. To keep gutters clean, and to sweep away impurities, it is an excellent plan to have a constant run of water along them; and with the occasional use of a scavenger's broom, gutters are far from being insanitary drains.

Drains.—The term drain is understood in sanitary matters to differ only from sewer in there being a difference in size of the two. Drains are pipes which convey sewerage and other matters from a house to the larger pipes, called sewers. In ordinary use, a drain is a pipe which conveys water or other matters apart from sewerage.

In the section dealing with water-closets in houses, it was stated what were the points to be attended to in connection with the drain leading from the W.C. to the outside drain; but this important subject requires a fuller reference. In cases where the house drain passes under the basement, great care is needed to prevent sewer-gas escaping into the house; and where the drain material is fireclay or stoneware, the joints should be made with cement, and a ring of concrete made right round the whole length of pipes. In case of blocks, access holes should be left, of course carefully sealed, but capable of being opened when necessary. A safer pipe for passing under the basement, however, is a cast-iron one, with the joints lead-caulked. The

best plan of all, however, is not to have drains passing under the basement at all, but to lead them through the external wall as quickly as possible. The continuation pipe from the W.C. to the outside soil pipe may be either made of lead or of cast-iron; when of the former, 7 lbs. lead to the superficial foot is needed, and the pipe should be solid drawn lead. When an iron pipe is used, it should be coated either with tar or "barffed," and the joints should be lead-caulked. Where a lead pipe joins an iron one, special precautions have to be taken with the joining, as from the unequal expansion and contraction of the two metals, and from galvanic action, leakage is apt to occur. For this purpose a brass ferrule should be soldered on to the lead pipe with a wiped joint, and the iron one caulked with lead to the ferrule.

The diameter of the soil pipe of a house should be four or five inches usually, and, as stated before, it should be carried up full bore above the rigging of the house, and well away from a chimney or window. An arch should be made in the wall over the exit of the house drain, as in case of subsidence of the wall the pipes would be crushed.

The next point to be attended to is the disconnection of the house drain proper from the outside or sewer pipe, so that sewer-gas may not pass from the sewer into the house drain. This is usually effected by using some form of trap in the case of a small house, or a disconnecting man-hole in the case of a large one. There are various traps in the market, and one of the most useful is Buchan's Ventilating Trap, well known in Scotland. Amongst others may be mentioned those of Doulton & Co., Banner, and Potts (Edinburgh Trap). The diameter of the trap should be less than of the pipe in front or behind it. By the insertion of a trap at the ground level, the soil pipe is cut off from the drain or sewer beyond by the "water-seal," and by the ventilating opening of the trap fresh air enters at this point, and an upward current is induced by the temperature of the soil pipe being higher than the entering air. There are various objections to traps, from their liability to evaporation of the water-seal, to be unsiphoned, to be choked up, to be forced by pressure from the sewers (this only in unventilated sewers), and to the water in the seal becoming charged with sewerage-gases; but notwithstanding objections such as these, they are indispensable. There is no good in

the multiplication of traps; the fewer they are, and the freer the ventilation of the drain, the better is the system.

Where a large number of drains and discharge pipes have to be disconnected a manhole is better, and this can be had either made of fireclay or can be built of bricks. This disconnecting contrivance consists of two parts—a chamber wide enough for a man to enter, and a siphon between this and the sewer. This siphon is usually provided with a raking arm, so that obstructions can be removed. The chamber is either covered up with a close-fitting lid, or with an open grating. In the former case a 6-inch iron pipe is used for ventilating the chamber. When built of bricks, these should be glazed and set in cement, and the floor of the chamber, made of concrete faced with cement, scooped out into channels corresponding to the various pipes that discharge into the disconnecting chamber.

In reference to other drains from a house, such as from baths, wash-hand basins, and sinks, these should not, on any account, discharge into the soil or sewerage pipe, but on to the grating of some trapped gully, or into a disconnecting chamber such as described. Further, in the case of sinks, these should be provided with grease interceptors, or else the drains will soon choke up.

Main Drains and Sewers.

Our remarks have been concerned with the drainage of a house till it reaches the disconnecting trap or chamber. The trap may lead into the main sewerage system, or there may be a continuation for some distance of the house drain, which may be made of stoneware, earthenware, or glazed fireclay, and of about four or five inches in diameter.

The term sewerage is applied to a complex liquid, consisting of human excretal matter, with the effete products of various trades and manufactures, the washings of streets, and the drainage from stables, cow-houses, slaughter-houses, etc., mixed up with a varying quantity of water. In the water-carriage system of sewage removal there must always be sufficient water to give a sufficient flushing power; but the quantity will depend greatly on whether the rainfall and subsoil water are allowed to enter the sewers or are excluded, as in the separate system, as it is called.

The composition of sewage varies according to whether W.C.'s

or middens are used, and in what proportion to each other, and also whether the rainfall and subsoil water are excluded or not.

According to the Rivers Pollution Commissioners, the chemical composition of sewage in towns with water-closets is as follows :—

Composition of sewage per 100,000 parts,—

72·2 solid matters in solution.

44·69 suspended matters.

The solid matter in solution contains,	4·696	organic carbon.
„ „ „	2·205	„ nitrogen.
„ „ „	6·703	ammonia.
Total combined,	7·728	nitrogen.
	10·66	chlorine.
Matters in suspension,	20·51	organic.
„ „	24·18	mineral.

The composition may vary widely from the above analysis according to the conditions noted. The money value of sewage of above composition per 100 tons is about 17s., or about 2d. per ton. Where middens are used instead of water-closets, the composition given by the Rivers Pollution Commissioners is,—

Midden town sewage per 100,000 parts,—

Total solids in solution,	82·4	
„ „ suspension,	39·11	
Composition of matters in solution,	4·181	organic carbon.
„ „	1·975	„ nitrogen.
„ „	5·435	ammonia.
„ „	6·451	combined nitrogen.
„ „	11·54	chlorine.
„ *in suspension,*	21·30	organic matters.
„ „	17·81	mineral matters.

Those analyses show that sewage is a valuable manurial substance, and when discharged into the sea is lost, and when into rivers not only is lost, but pollutes them, to the injury of their primary purposes. Before any system of sewerage is adopted, an inquiry embracing the following considerations has to be made :—

1. Area of the district to be sewered.
2. The rainfall of the district, and the proportion it is intended or desirable to admit into the sewers.
3. The geological character and physical outline of the district.
4. The present and prospective number of its inhabitants.
5. The supply of water in the district.
6. The sanitary appliances at present in operation, or to be adopted.
7. The position of the outfall, and the mode of disposing of the sewage. (Latham's *Sanitary Engineering*.)

Those important considerations engage the attention of sanitary engineers, and no important sewerage work should be undertaken without their advice, as upon the efficient construction of sewers in every detail the success of the whole system depends.

Materials used for Sewers.

Sewers may be made of stones, bricks, iron, cement, mortar, stoneware, and fireclay. Up to 18 inches diameter stoneware or fireclay pipes are used; above that, sewers are usually constructed of bricks. In selecting stoneware or fireclay pipes the greatest care should be exercised to prevent bad material being used; and the following points are usually insisted on by sanitary engineers: the pipes should be made true in section, the thickness uniform, and in relation to diameter of pipe, straight, glazed outside and inside, tough and hard, homogeneous, free from flaws and cracks, and when struck they should ring clearly. They should have a spigot on one end and faucet on the other. The pipes should not contain any material liable to be acted on by the sewage matter or gases. Engineers subject sewage pipes to certain mechanical and chemical tests to try their impermeability, their toughness, and resistance to fracture and to the action of chemicals. Latham, in his work already quoted, speaks very highly of silicated concrete pipes extensively used in Germany, and which possess many qualities not found in fireclay or stoneware goods. These improve with age, are tough and resistant to shock and fracture, and joints are more easily and securely made with cement than in fireclay or stoneware pipes. For the main outfalls and for sizes above 18 inches, sewers are usually made of bricks, which require

as careful choosing as sewer pipes. They should be well burnt, tough, and hard. Invert blocks are made either solid or hollow.

The thickness of brickwork can be found by the following formula (from Latham): $\frac{d\ r}{100}$, when d = depth of excavation, and r external radius of sewer. Sewers not exceeding 3 feet in internal diameter, and with depth of track not over 20 feet, may be made of 4½-inch ring of brickwork.

Sectional Form of Sewers.—Whether made of fireclay, stoneware, concrete, or bricks, sewers may be circular or oval, according to circumstances. Where the volume of sewage is large and uniform, the circular form is adopted; but where there is variation it is necessary to adopt the oval, to have a maximum amount of flushing with a minimum flow of sewage. In the new form of oval sewer the following dimensions are used :—Vertical height, 1½ times transverse diameter; radius of invert, ⅛ of transverse diameter. In cases where it is desirable to carry off the subsoil water, a form of pipe with a hollow invert is used, or Brook's pipe, where there is a special subsoil drain pipe under the sewage pipe, and which serves as the foundation for the sewer. This plan is not approved by Latham, who prefers a special pipe put in the pipe track separate from the sewer pipe.

Special forms of pipes may be noted, such as Jennings', which are laid in chairs, like rails on a railway, and with detachable parts in the pipe for access in case of blocks. Doulton provides a capped pipe also for this latter purpose.

As regards the joints of pipes, the greatest care has to be taken to make them sound, and thus prevent leakage of sewage and sewer-air. In Stanford's pipes a special joint is provided by casting upon the spigot and in the socket of each pipe rings of cheap and durable material, the composition consisting of ground earthenware pipes, sulphur, and tar. The pipes, when put in apposition, fit accurately. The surfaces of the rings may first be greased or tarred. In ordinary spigot and faucet pipes, the joints should be made with neat cement, or with equal parts of sand and cement, and care should be taken that the cement is not forced into the interior of the pipes, and thus lead to choking up afterwards. To prevent this occurring, it is recommended, before putting on the cement, to insert a ring of tarred gasket. Another good material for joints is asphalte. Clay should not be used

on any account, as it dries, cracks, and falls out of the joint. Whatever material is used for joints, the pipes should not be covered in the track till they are examined and tested by filling them with water under pressure. Any flaw will be discovered by leakage. The faucet end of a pipe should face the flow of sewage. As regards the pipe track, in some cases where the subsoil is unstable, a concrete foundation may have to be made. A point of importance in laying pipes is to see that they lie evenly along the bottom of the track, and this can only be done by scooping out the soil so that the faucets may rest in the depressions. If this is not done, the pipe becomes like a bridge supported at each end, and the weight of soil above may lead to fracture.

Junctions.—Branch drains should not enter at right angles into the main, but in the direction of the latter, otherwise eddies are caused, leading to obstruction. The junction should be by a proper oblique pipe, entering neither above nor below the water line of the sewer. One very common method of forming a junction is to break a hole in the sewer pipe and lead the branch into this, frequently at right angles, and then to surround the junction with cement. This is a wrong method, and junctions should be made by an obliquely curved pipe.

When branches join the main sewer at right angles, this should be effected by means of a manhole, with curved channels in its floor corresponding to the branches.

Course of Sewers.—Modern sewers are now generally laid in straight lines; and where any lateral deviation occurs, a manhole is constructed, also manholes, ventilators, or lampholes at every vertical deviation or altered gradient. If an obstruction occurs, a man can descend the manhole, while a lamp is dropped into the sewer by the lamphole, and by looking towards this the obstruction is discovered, and can be then removed by tools for the purpose, without causing the great expense and nuisance of having to break up the ground, as used formerly to be done, when sewers were not thus constructed.

Gradients in Sewers. — In order that sewers may be self-cleansing, they must have a fall in proportion to the diameter of the sewer. The following gradients are used:—

For a 4-in. pipe, 1 in 40.
„ 6 „ 1 in 60.
„ 9 „ 1 in 80

Latham recommends that in sewers of from 6 to 9 inches in diameter a velocity of 180 feet per minute should be produced, and in sewers of from 12 to 24 inches a velocity of 150 feet per minute; and in no case should there be a velocity of less than 120 feet per minute.

In cases where proper gradients cannot be got, or where, for other reasons, a better flush is desirable than can be got from differences in level of the sewers, other means are used. For house drains one of the best arrangements is Field's automatic flushing tank. A common plan in main sewers is to dam up the sewage by what is called a flushing gate, and then suddenly liberating it a rush is produced which carries away obstructions. Those flushing gates are sometimes made so as to be self-acting. A manhole may be utilised for a flushing apparatus to act in. Latham refers to an arrangement of his own for small sewers. An earthenware flushing-block is built into the head of every sewer running out of a manhole. The flushing-blocks have ground faces, against which a wooden disc is placed, and this is retained in position by the pressure of water behind it. The disc is connected with a chain attached to a float, so that if by neglect the disc is left fixed, the water rising liberates it and allows the sewage to escape. For heads of sewers a tilting flushing tank may be used, or Field's flushing tank, already referred to.

Ventilation of Sewers.—For every 100 yards of sewer there should be some opening to the external air, either by manhole, lamphole, or special ventilator. Where no special form is needed, an opening made into the crown of the sewer, carried to the street level, and covered over by a grating, is sufficient. If the street is wide, and the ventilator opens in the middle, there is no objection from smell; but in narrow streets there should be a pipe conveyed from the sewer to above the level of the houses. In situations where the gradients are steep, to prevent sewer-air travelling to the higher levels, sewers have to be broken up into steps, and provided with valves and ventilators. The valves are lightly balanced, and open with the flow of sewage, but close with a current of air passing backwards, which, however, finds exit by the ventilators provided.

The use of charcoal to deodorise sewage gas has not been a success in practice, and need not be discussed. Regarding the

question of ventilation of sewers by special shafts, or utilising the furnaces and chimneys of manufactories, they are beyond the scope of this treatise.

Air of Sewers.—The air of sewers may be nearly as pure as that of the general atmosphere when all the conditions which characterize a properly constructed sewer are present. But in badly constructed sewers, with deficient gradients, badly made joints and junctions, insufficient air openings, and not laid in straight lines, and such like defects, the air is often very foul, and the following gases make their appearance :—Carbonic acid, carbonic oxide and carburetted hydrogen, hydrogen and ammonium sulphides and carbon disulphide. Oxygen becomes very much diminished, and organic matter, micro-organisms, fungi, etc., are increased. Professor Carnelley's experiments show, however, that micro-organisms in well-ventilated sewers are not numerous.

Where sewage is discharged into the sea, and the sewer is tide-locked at certain periods of the day, valves are required to prevent the sea backing into the sewers. These valves also prevent winds blowing up the sewer and reversing the current of sewer-air, which usually follows the direction of the sewage. Tank sewers are often necessary to store up sewerage until the tide is ebbing. The outfall of the main sewer should be so situated as to take advantage of any sea currents, so that the sewage may be taken out to sea, and not brought back to the shore by the flowing tide.

Shone's System of Sewage Removal.

In cases where sewage has to be raised against gravity some mechanical power has to be used, and Shone's system is specially useful in such cases. In this system the propulsive power is compressed air, which is conveyed by 2-inch wrought-iron pipes to the "ejectors." The ejectors are spherical in shape, 5 feet in diameter, and made of cast-iron. By mechanical devices the filling and emptying of these ejectors are performed automatically. The sewage, when it accumulates to a certain extent in the ejcetors, is acted on by the compressed air. A valve opens and the sewage is forced into the discharge pipe to either the ordinary sewer pipes or to closed iron ones, according to the necessities of the case.

The application of this system promises to be yet more general;

and if "ejectors" and closed iron pipes were used instead of the present system, the problem of sewer ventilation would be much less formidable than now.

Mention may be made of the Berlier and Liernur Systems; but neither has met with much favour in this country, though somewhat extensively used on the Continent. A very short reference may be made to Liernur's System.

Liernur's System.

This consists essentially of air-tight iron tanks situated under the streets, and connected by iron pipes with the closets in the houses. These tanks are connected by two sets of pipes with works outside the town where air-pumping machinery is placed. A vacuum is produced in these iron tanks, and at stated times the valves between them and the house pipes are opened, and by atmospheric pressure from behind the sewage matters are forced into the tanks. As soon as the street tanks are filled, air is admitted to them, the valve leading into the vacuum sewage pipe opened, and the sewage is forced along this to the large reservoir at the works, where it undergoes treatment. In the system there are two distinct kinds of pipes needed, one for household waste water, rain, etc., and the other for water-closets, etc.

This system has been variously described as being a great nuisance and as working satisfactorily, but it has not met with favour in this country.

Sewage Disposal.

How sewage is to be disposed of after removal from a given district is one of the most difficult and important sanitary problems. Where the sea is near, then even at the waste of so much manure it may very properly be discharged into it; but in inland districts this is out of the question, and to discharge sewage into rivers and running waters generally is a distinct breach of the Rivers Pollution Act; and the question remains, how is sewage to be disposed of? Corfield, in his valuable work on the "*Treatment and Utilisation of Sewage*," points out certain conditions to be observed in any scheme of sewage disposal, and these are :—

1. The first thing to be attained is the purification of the sewage to such an extent that the effluent water may be safely allowed to flow into a watercourse.
2. The next is the application of it as an agricultural manure in such quantities and in such a manner as to realise the greatest returns per ton of the sewage and per acre of land.
3. That the health of the inhabitants of the irrigated districts shall in no way be affected injuriously by the process.

The various schemes which have been proposed for the treatment and utilisation of sewage are innumerable, and space will not permit more than mere mention of some of the most important.

Precipitation Processes.—In these chemical agents are introduced into the sewage, a deposit of solid matters takes place, and the "effluent" water is rendered more or less pure, but seldom or never so pure as to be discharged into running waters. The usual chemicals are lime or lime and iron, alum, salts of magnesia, manganese.

In **Scott's Plan**, lime and clay are added to the sewage at a considerable distance from the outfalls. A sludge is formed which is pressed, dried, and then burnt, and cement made. The effluent is not pure.

Whitethread's Process consists in adding to the sewage two parts of dicalcic phosphate, one of monocalcic phosphate, and a little milk of lime. The effluent should be used for irrigation. These are examples of precipitation methods, and none are sufficient of themselves to purify sewage, but may be used preliminary to some form of filtration.

Filtration may be upwards, downwards, constant or intermittent, and through soils, carbon, or mere screeners.

Intermittent downward Filtration.—This process consists in the concentration of sewage at short intervals on an area of specially chosen porous ground, as small as will absorb and cleanse it, not excluding vegetation, but making the produce of secondary importance. Intermittency of application is a *sine quâ non.*

When sewage is passed through soil, several changes take place, viz. simple filtration, precipitation, and retention by the soil of ammonia and various organic substances previously in solution; and of much importance, oxidation of ammonia and organic matter

by the agency of living organisms. For intermittent downward filtration a porous soil is needed; and if it is not, it must be made so, and then deep drained to 7 feet or so. The area is laid out into beds, say 1 acre divided into four beds, intersected by paths, along which the main carriers run. The sewage is screened first to remove solids and distributed intermittingly, each part in the above acre receiving sewage for six hours. Vegetables can be grown on the filter beds. About 1 acre for every 1500 to 2000 people is needed.

Irrigation.—This is now admitted to be the only method of sewage disposal which meets all the requirements of the efficient treatment of sewage, but every detail must be carefully carried out to ensure success.

By irrigation is meant the distribution of sewage over a large surface of ordinary agricultural ground, so as to secure a maximum growth of vegetation for the amount of sewage supplied. It is absolutely necessary, where a profit is wished from this mode of sewage disposal, that the working expenses should be cut as low as possible, and no expensive or complicated apparatus employed. The sewage should flow on to the land by gravitation. The rent of the land should not be more than its ordinary agricultural value, and the quantity should be about 1 acre for every 100 people. The soil should be porous, sand, gravel, or loam; but clay may be broken up and mixed with ashes, so as to be made pervious. Deep draining to the depth of 6 feet is usually necessary.

The sewage should be delivered in a fresh state, and freed from the larger portions by straining or precipitation. The delivery should be intermittent, so as to allow the soil to become aerated. Different crops should be grown in rotation, such as Italian rye grass, peas, beans, cabbage, turnips, etc.

The manner in which the sewage is distributed over the land is important, and the following description (Eassie, *Healthy Homes*) may be useful. The sewage is first received into a small regulating chamber, out of this a pipe leads into two subsiding tanks placed on either side of the regulating chamber. The tanks are fitted with double gratings, with straw placed between to strain the sewage.

In the regulating chamber is placed a gauging apparatus, which regulates the flow of the storm-water. In periods of

excessive rainfall the storm-water flows over it and falls into an outfall pipe.

When the settling tanks are quite filled, the water is drawn off by a valve and the solids are allowed to dry, and are then removed.

The sewage, after having been thus strained, is allowed to flow over the soil; and for this purpose special carrier pipes may be used, made of concrete or fireclay; or the carriers may just be furrows made by the plough or spade. To divert the sewage into sub-channels, small sluice gates are used.

The ground may be arranged on the contour, ridge and furrow, or pane and gutter system. The "ridge and furrow" system answers best, and a short description of this is necessary.

The surface is laid out in ridges from 30 to 60 feet broad; between each ridge is a furrow slightly lower than the ridges; a small grip passes down the centre of the ridge. Along the tops of the ridges is the main sewage carrier, and the workmen, by means of the little sluices already referred to, or by means of a board, dam up the sewage at the ridge which they wish irrigated. The sewage runs down the centre of the ridge, and what is not absorbed by the soil runs into the furrows bordering the ridge.

When the small cutting or grip which runs along the middle of the ridge becomes clogged, it should be replaced by another.

It will be seen that no expensive fittings are needed; and when carefully managed, sewage may be safely disposed of without danger to the public health, and if not with profit, without serious loss.

Subsoil Irrigation.—This method, which is intended for the disposal of the sewage of mansions, or even of small villages, requires some description. In this system the sewage is collected into a flushing tank (Field's). Subsoil drains about a foot deep, with open joints, convey the sewage into the soil, and this coming into contact with the roots of plants, purification takes place. There may have to be deeper drains under those 1 foot deep, and the shallow ones should be lifted once a year, cleared out, and then relaid. This simple plan deserves more frequent adoption than it has met with; and in many cases the sewage matters of mansions and of villages might thus be got rid of cheaply and effectively, and what is of more importance, without any risk to

the public health or production of nuisance. Of course, care must be taken that the subsoil drains do not lead to any pollution of the source of any water used for domestic purposes, by keeping in remembrance that pollution may act at a long distance by means of subsoil water.

Powers and Duties of Local Authorities.

It has been already stated that Local Authorities have, under certain conditions, the power to construct a sewer, to replace a ditch, gutter, or drain in a foul state (section XXIV. of the Act). All sewers in a district, and not being private property or under the management of the Crown, are vested in the Local Authority. The Local Authority have further the right to purchase sewers, and to make sewers within their district, and for purposes of outfall or distribution of sewage outside their district. The Local Authority shall cause their sewers to be so constructed, kept, and cleansed as not to be a nuisance (section LXXIII.). The Local Authority have powers for utilising sewage, and may agree with any person as to the supply of such sewage. No contract for a period exceeding five years to be made without consent of the Board. The Local Authority have power of entry to any premises, to examine, measure, survey, etc.; and if admission is refused, the Local Authority may apply to the Sheriff for warrant to enter and do all needful work (LXXII., LXXIII.).

Any owner or occupier of premises within the district of a Local Authority, liable for general or special drainage or sewerage assessment, can drain into sewers of Local Authority after giving twenty days' notice; but must comply with regulations as to the making of connections. This is an important clause, and should be carefully observed, as a main sewer may be ruined by badly made connections. Users of sewers who are beyond the district of a Local Authority, are subject to such conditions as are agreed on by the Local Authority and owner or occupier. Disputes to be settled by Sheriff (sections LXXVII., LXXVIII.).

There are penalties attached to the making of unauthorised drains into sewers.

Before entering into any contract for the construction of sewage or drainage works, the expense of which exceeds £30, the Local Authority must procure from a surveyor (or skilled person) an estimate and report. Buildings are not to be erected

over sewers; and no vault, arch, or cellar is to be made so as to interfere with any such sewer.

In section LXXXII. a special provision is made as to sewers being trapped, so as to prevent stench or deleterious exhalation. This is vague, and very deficient in stringency. Local Authorities should have the power to make bye-laws dealing with the whole question of sewers, including trapping and ventilation. Owners and occupiers of distilleries, manufactories, etc., shall be compelled to construct pools or reservoirs for receiving and depositing the refuse of such works *so far as offensive or injurious* to the health of those living in the vicinity, or to use the best means of rendering it inoffensive or innocuous, before discharging it into any ditch, sewer, channel, river, or stream. An opinion has been given that in this section "offensive" is distinct from "injurious to health," and that it is not necessary to prove that the refuse is injurious to health (section LXXXIII.).

The Local Authority has power to compel the owner of any dwelling-house, distillery, manufactory, or other work or erection, to provide an effective drain for these. And the Local Authority may, by notice, require the owner within a certain time to make such sufficient drain entering into sewer of Local Authority, provided this is within 100 feet of the above premises; but if beyond, then into a cesspool or other place not being under any house. The Local Authority may do the work, if not complied with, within specified time, and recover expenses from the owner in summary manner.

Two or more Local Authorities may combine to carry out sewerage or water schemes.

No. 17.—*Petition to Sheriff by Owner or Occupier to fix terms of communicating with Drains, sect.* 78.

PETITION TO THE SHERIFF.

Unto the Honourable the Sheriff of , the petition of , against the Local Authority of ,

Humbly sheweth,—

That the petitioner is the [*owner or occupier, etc., as in sect.* 78; *state if without district, or not liable to assessment*], and he is desirous that a [*sewer or drain, describe it*] from the said premises shall, as provided by the Public Health (Scotland) Act, 1867, be made to communicate with a sewer of the Local Authority, viz.

[*describe it*]; but the petitioner and the Local Authority have been unable to agree on the terms and conditions on which such communication is to be allowed, whereby this application becomes necessary under this Act. The petitioner is ready to agree to the following terms, viz. [*state what petitioner proposes*], or such other terms or conditions as your Lordship may deem just.

May it therefore please your Lordship to appoint this petition and the deliverance thereon to be served on the said Local Authority, and appoint answers to be lodged within three days, or appoint the parties to appear before your Lordship at a time and place specified, and thereafter to find that the petitioner is entitled to make the aforesaid communication betwixt [*specify the two drains or sewers*], on the terms and conditions before specified, or such others as your Lordship may deem just.

According to justice.

INTERLOCUTOR.

[*Place and date.*]

The Sheriff [*see prayer*].

CERTIFICATE OF SERVICE.

I, , certify that I have served a copy of the foregoing petition and deliverance on , therein mentioned, on the day of , at o'clock .M., by [*state mode of service under sect.* 110], in presence of the undersigned witness, viz.,

, *witness.*

No. 18.—*Notice by the Local Authority to the Owner of Premises to make a Drain, sect.* 85.

NOTICE.

The Local Authority of hereby, in terms of sect. 85 of the Public Health (Scotland) Act, 1867, give notice to you , owner of , and require you, within from the date of service hereof, to make a sufficient drain from the said premises [*state how the drain is to empty itself, in one of the modes mentioned in sect.* 85], and if you fail, the Local Authority will proceed in terms of the said Act.

, *Sanitary Inspector.*

CERTIFICATE OF SERVICE.

I, , certify that I have served a notice, of which the foregoing is a copy, on therein mentioned, on the day of , at o'clock .M., by [*state mode of service, as,* by putting the same into the Post Office at addressed (*state address*); *or*, by delivering the same to

him personally at etc. (*see sect.* 110)], in presence of the undersigned witness, viz.,

, *witness.*

Formation of Special Drainage District.

Upon requisition made by writing by not less than ten inhabitants (not necessarily ratepayers), the Local Authority shall be bound to meet, after twenty-one days' notice, and shall consider the propriety of forming part of their district into a special drainage district. The resolution of the Local Authority at such meeting shall be published in one or more newspapers circulating in the district. The production of this newspaper, or a certificate under the hand of the chairman or acting clerk of the Local Authority, shall be sufficient evidence of such resolution. Within ten days of such resolution any interested person may appeal to the Sheriff, and the Sheriff, not being a Sheriff-Substitute residing within the district, may either approve or disapprove of such resolution ; and if he disapproves thereof, he may either find that no special drainage district should be formed, or may enlarge or limit the special district as defined by the resolution of the Local Authority, or may find that a special drainage district should be formed, and may define the limits thereof. The decision of the Sheriff is final and binding on the Local Authority. The decision of a Sheriff-Substitute may be appealed against.

By the Public Health (Scotland) Amendment Act, 1879, upon requisition signed by ten inhabitants of the district, the Local Authority shall be bound to meet, after twenty-one days' notice of the meeting has been given to the members, to consider the question of altering, by limiting or enlarging, boundaries of any special drainage or sewerage district, or of combining two or more special drainage districts or portions thereof. If the Local Authority resolve upon any such alteration or combination, its resolution shall be advertised. The decision is subject to review, as in Act of 1867. This Amending Act provides for special water districts being dealt with in same manner as above stated.

Form of Requisition for Special Drainage District.

Unto the Local Authority of , the requisition of the undersigned, being not fewer than ten inhabitants of the district of the said Local Authority.

We, the inhabitants of the said district, hereby, in terms of

[sect. 76] of the Public Health (Scotland) Act, 1867, require you, the said Local Authority, to meet and consider the propriety of forming, and thereafter to form, the following part of your district into a special drainage district, viz. , or according to such other description or boundaries as may seem fit.

Signatures. *Places of residence.*

Appeal to the Sheriff of County of .

Appeal for , in terms of [sect. 76] of the Public Health (Scotland) Act, 1867.

We appeal against the resolution of the Local Authority , adopted on or about , relative to the formation of a special drainage district, and

Pray your Worship to ; or to do otherwise in the premises as may seem fit.

Urinals.

Urinals, unless carefully supervised and of good construction, become great nuisances. They may either be in public places, or in workshops, manufactories, etc., but are not often needed in private houses.

Different forms are used, and made of different materials. For public places, such as streets or railway stations, some sort of house is needed, and this may be stonework, brickwork, or iron, and freely ventilated at the roof. The inside walls should be made impervious, by coating the iron or stonework with coal-tar, or by lining with glazed or enamelled bricks. The floor should be impervious, and slope to a grating leading to a gully, trapped so as to insure complete disconnection with the sewer it communicates with. Usually urinal basins are provided, made of stoneware or earthenware. Where there are stalls alone, the material may be iron coated with tar, slate painted, rough glass, or some such impervious material. A constant run of water, from perforations in a copper pipe, should flush the parts fouled in the case of stalls; all basins should also have water constantly running into them, or be flushed by an automatic arrangement.

There should be complete disconnection between urinals and the main sewer by proper traps, as already stated; and the house should be open to the air for ventilation.

Importance of good Sewerage and Drainage Systems.

In a former chapter certain diseases of common occurrence, and often of widespread prevalence, were referred to as filth-diseases, from their intimate causal relationship to "filth." Such diseases, or some of them, are intimately related to that form of filth depending upon defective, or entire absence of, sewerage systems; such are, typhoid fever, cholera, diphtheria, and ordinary "sore throats."

The following table from the Registrar-General's Reports (England) will show the effect of improved sanitation subsequent to the passing of various Public Health Acts in England:—

Public Health Act.	Period of Years.	Mean Annual Death-rate per 1000 living.
1872, . . .	Ten years, 1862–71	22·6
,, . . .	Four years, 1872–75	21·8
1875, . . .	Five years, 1876–80	20·79
,, . . .	Five years, 1881–85	19·30
,, . . .	1886	19·28
,, . . .	1887	18·79
,, . . .	1888	17·83

The report made by Dr. Buchanan in 1867 on twenty-five towns shows very strikingly the influence of definite sanitary works on the mortality from typhoid fever and phthisis.

EFFECT OF SANITARY WORKS ON MORTALITY FROM TYPHOID AND PHTHISIS.

TOWNS.	Reduction of Typhoid per cent.	Reduction of Phthisis per cent.
Banbury, . . .	48	41
Cardiff, . . .	40	17
Croydon, . . .	63	17
Dover, . . .	36	20
Ely, . . .	56	47
Leicester, . . .	48	32
Macclesfield, . .	48	31
Merthyr, . . .	60	11
Newport, . . .	36	32
Rugby, . . .	10	43
Salisbury, . .	75	19
Warwick, . . .	52	19

The reduction of the death-rate is not confined to zymotic diseases alone, but is experienced in the general death-rate, for the average death-rate in those towns above referred to was reduced from 25·6 per 1000 to 21·7.

Speaking from my own experience in a district where typhoid was almost endemic, the introduction of a new sewerage system led to a most pronounced diminution of typhoid fever; and even under unfavourable circumstances, as there was no system of ash removal, and other insanitary conditions abounded.

CHAPTER VI.

(SECT. XVI. SUBSECT. B.)

Water and Water Supplies.

In the section we are now dealing with, wells and water supplies, used as beverages or in the preparation of human food, are referred to specially; but the whole question of water supply is of so immense importance, that a somewhat full reference to it is necessary. It may sometimes be easy to say that a water is foul from the simplest of examinations, such as noting the source of the water, or its smell or turbidity; but usually those simple tests are not sufficient, and the aid of the analyst is called in. Now the object of an analysis is to obtain an opinion of the degree of purity or impurity of a given water, and not to deceive the analyst, so that it is wise to give him the fullest information possible, and put him in a position to give a reliable opinion. A reliable opinion cannot be invariably given by mere chemical analysis, and the following information is recommended to be supplied:—

1. Source of water, as from tank, cistern, spring, pump, etc.
2. Position of source, strata.
3. If a well: depth, diameter, strata, steined imperviously or not, and how far down. Depth of well, depth of water. If well is open, covered, or with a pump.
4. Possibility of impurities, proximity of possible contaminants, cultivated ground.
5. If surface or rain water: nature of collecting surface, and condition of storage.
6. Recent drought or rainfall.
7. Statement of any diseases supposed to be connected with water supply. (Parkes' *Hygiene*, abridged.)

Any further information bearing on the question will be useful to the analyst. The quantity of water for an analysis is usually half a gallon, and this may be conveniently sent in a Winchester

quart, obtainable from druggists, and it should be carefully cleaned out by washing. Wanklyn recommends rinsing out with sulphuric acid, and again washing out with pure water. The bottle should be washed out with some of the water, to be analysed, and then filled by dipping under the water, if from a well or cistern, taking care not to fill the bottle too full. It should then be stoppered with its own glass stopper or a new cork, and then tied down without using any luting. The sooner the analyst receives the sample the better.

It is impossible to enter into the wide question of water analysis, and also so far unnecessary, but it is important to have a clear conception what an analysis indicates. This is not easy, even for those familiar with such subjects, as different analysts use different methods, and attach greater importance to one ingredient in a water than another. There are certain broad principles, however, which should guide us in forming an opinion, and these we will indicate. Absolutely pure water does not exist in nature, and can only be obtained with much trouble and in very small quantities by chemical and physical means. The purest water in nature contains, in greater or lesser quantities, various animal, vegetable, mineral, metallic, and gaseous matters, some in suspension and some in solution. Where some of these are in comparatively small amount we say the water is pure, though others in the smallest degree would cause the water to be dangerous in the extreme.

As showing how complex water is in its composition, I give the following example (from Chaumont's *Lectures on State Medicine*):—

COMPOSITION OF WATER.

A.—Gaseous contents, . .	Carbonic acid. Oxygen. Nitrogen.	Useful gases.
	Hydrogen sulphide. Ammonium sulphide. Ammonia.	Noxious gases, results of decomposition.
B.—Dissolved solids, . .		
a Mineral matters, .	Calcium. Magnesium. Chlorine. Sulphuric acid. Phosphoric acid. Sodium. Potassium. Iron. Silicon. Manganese. Aluminium.	

b. Products of organic oxidation, . . .	Nitric acid. Nitrous acid. Ammonium salts.
c. Organic matter, .	1. Capable of putrescence or oxidation. 2. Incapable of putrescence or oxidation.
C.—*a.* Mineral matter, . .	Crystallised. Amorphous.
b. Organic matter, . . 1. Dead, ...	Amorphous. Organised but decaying. Fibres. Epithelium, pus, etc.
2. Living, . . .	Spores, seeds, etc. Bacteria, fungi. Infusoria. Crustaceans, etc. Eggs of parasites, etc.

An analysis does not usually enter into all those particulars, but the following points should be attended to in forming an opinion as to a water's fitness for domestic use:—

1. **Physical Characters.**—It should be colourless, though some excellent waters have a distinct colour, bright, sparkling, free from taste and smell. Smell may be brought out by warming the sample. Microscopic examination should show it to be free from the larger forms of parasites or their ova, or matters indicating pollution from animal sources. Microscopic examination should include the examination by Koch's Gelatine Test, and the number of micro-organisms found per cubic centimetre should be stated.

The following examples from examinations made by myself will show how the number of "colonies" vary in different waters:—

VERY PURE WATER, per 5 drops,—

Colonies, . . 20, 14, 27, 25.

IMPURE WATER, colonies countless,—

Organic matter = 1. Colonies, 20.
Organic matter = 2. Colonies, 42.

The cultivation method of Koch, with reservations and precautions, is a valuable adjunct to a water analysis by chemical means, and a short reference to this means of water examination will be given farther on.

2. **Chemical Analysis.**—It is beyond the present scope to enter more than generally into this part of a water analysis. The

following specimens of good, usable, and impure waters may be found useful:—

GOOD WATER—

Physical Characters.—Colourless or bluish tint, transparent, sparkling, and well aerated; no sediment visible to naked eye; no smell; taste palatable.

Chemical Constituents.		Grains per Gallon.	Remarks.
1. Chlorine in chlorides,	under	1	May be exceeded.
2. Solids in solution, total,	,,	5	May be exceeded.
,, ,, volatile,	,,	1	In chalk districts.
3. Ammonia, free or saline,	,,	·0014	
,, albuminoid,	,,	·0035	
4. Nitric acid in nitrates,	,,	·0226	
Nitrous acid in nitrites, . .		nil.	
Nitrogen in nitrates, under . .		·0100	
Total combined nitrogen, including that in free ammonia, .		·0112	
Total combined albuminoid, including that in free ammonia, .		·0160	
5. Oxygen absorbed within half an hour at 140° F., under . .		·0175	May be doubled in peat or upland surface waters.
Oxygen absorbed in 15 minutes at 80° F., under . . .		·0100	
Oxygen absorbed in 4 hours at 80° F., under . . .		·0350	
6. Hardness, total, under . . .		6°	
,, fixed, ,, ...		2°	
7. Phosphoric acid, ...		traces.	
Sulphuric acid, ...		traces.	
8. Heavy metals, ...		nil.	
9. Hydrogen and alkaline sulphides,		nil.	

Microscopic Characters.—Mineral matter; vegetable forms with endochrome; large animal forms; no organic debris.

USABLE WATER—

Physical Characters.—Colourless or slightly greenish tint, transparent, sparkling, and well aerated; no suspended matter, or else easily separated by coarse filtration or subsidence; no smell; taste palatable. (Note in some usable waters colour may be brownish, as peat waters. Taste may be flat or only moderately palatable.)

Chemical Constituents.		Grains per Gallon.	Remarks.
1. Chlorine in chlorides, . . .		3	May be larger in waters near sea.
2. Solids in solution, total,	under	30	Solids may blacken, but no nitrous fumes given off.
,, ,, volatile,	,,	3	

Chemical Constituents.	Grains per Gallon.	Remarks.
3. Ammonia, free or saline, under .	·0035	Greater in deep wells.
,, albuminoid, ,, .	·0070	Greater in upland surface, peat, etc., vegetable source.
4. Nitric acid, . . ,, .	·3500	Doubtful value.
Nitrous acid, ...	nil.	
Total combined nitrogen, including that in ammonia, . .	·0819	
Total nitrogen, including that in albuminoid ammonia, . .	·0876	
5. Oxygen absorbed in 30 minutes at 140°, ...	·0700	May be doubled in upland surface and peat waters.
Oxygen absorbed in 15 minutes at 80°, ...	·0210	
Oxygen absorbed in 40 minutes at 80°, ...	·1050	
6. Hardness, total, under .	12°	
,, permanent, ,, .	4°	
7. Phosphoric acid, ...	traces.	
Sulphuric acid, ...	2·000	
8. Heavy metals, iron, ...	traces.	
9. Hydrogen and alkaline sulphides,	nil.	

Microscopic as in pure water.

IMPURE WATER—

Physical Characters.—Colour, yellow or brown; turbid, and not easily purified by coarse filtration; large amount of suspended matter; any marked taste or smell. (Dark-coloured waters may be used when impurity is vegetable.)

Chemical Constituents.	Grains per Gallon.	Remarks.
1. Chlorine in chlorides, above .	5·000	Hurtful per se. when magnesian.
2. Solids in solution, total, . .	50·000	
,, ,, volatile, . .	5·000	Some waters, organically pure, contain large quantities of solids.
3. Ammonia, free or saline, above	·0070	
4. Nitric acid in nitrites, ,,	·700	
Nitrous acid in nitrites, ,,	·0350	
Nitrogen in nitrates and nitrites, above	·1690	
Total combined nitrogen, including in free ammonia, . .	·1748	
Total nitrogen, including in albuminoid ammonia, . . .	·1821	
5. Oxygen absorbed in 30 minutes at 140°, ...	·1050	In absence of free ammonia or much chlorine, may be due to vegetable matter.
Oxygen absorbed in 15 minutes at 80°, ...	·0700	
Oxygen absorbed in 4 hours at 80°, ...	·2800	

Chemical Constituents	Grains per Gallon.	Remarks.
6. Hardness, total, .	20°	
„ permanent, .	6°	
7. Phosphoric acid, . . .	very heavy traces.	
Sulphuric acid, ...	3·000	
8. Heavy metals, any except iron, .	nil.	
9. Hydrogen and alkaline sulphides,	present.	

Microscopic Characters. — Bacteria of any kind; fungi numerous; vegetable and animal forms of low types; epithelia or other animal structures; evidences of sewage; ova of parasites.

These examples of a very pure, usable, and impure water (from Parkes' *Hygiene*) will show how widely the different constituents may vary, and without always indicating any impurity in the water. The subject is highly technical, but a comparison of any water analysis with these would guide the uninitiated to form an opinion.

General Sources of Water.

The ocean, which covers such a large proportion of the earth's surface, is the principal source from which rain is derived; and on rainfall we depend directly or indirectly for all water supplies. The computed ratio of land to water is about 1 to 4, and from this vast sheet of water by the action of the sun's heat, water is constantly passing into the atmosphere as invisible vapour. This process of evaporation is not confined to sheets of water, but to all varieties of water, such as snow, ice or hail, and the water occurring as moisture in the soil. The quantity of water which thus passes into the air can be more easily imagined than measured, and measurements by instruments for the purpose are fallacious; various conditions determine the rapidity with which evaporation goes on, but temperature plays the most prominent part. The higher the temperature of the air above that of the evaporating surface the more freely does evaporation go on, and this is very much promoted by moving masses of air, especially when dry; thus dry winds quickly dry up moisture. A useful experience of the drying action of air is felt when, after a fall of snow and a thaw, a wind sets in, quickly removing the snow by evaporating it into the atmosphere. Water thus passing invisibly into the atmosphere meets colder currents, and passes into visible mists, fogs, and clouds. It has been proved by Mr.

Aitken that unless there is some nucleus in the air, no fog or cloud can be produced by the condensation of aqueous vapour. (*Transactions of Royal Society, Ed.* vol. xxx.) Fogs are frequently noticed on hill-tops, because there the moist warm air coming in contact with the cold hill-tops has its temperature reduced, and condensation occurs in consequence. Clouds are just the same as fogs and mists, are produced in the same way, and are interesting here only as carriers of water from the ocean and all water surfaces. The clouds are brought inland by winds, and deposit their contained water in the form of rain, snow, or hail. The quantity that falls is the rainfall of the district, and is of the greatest importance as the source of all water supplies. There are very many factors at work determining the amount of rainfall, and no preconceived ideas can be formed as to how much ought to fall; but this can only be determined by the use of rain-gauges, and over a series of years, as the quantity varies much in different years; and generally it is experienced that the maximum quantity for one year exceeds the mean by $\frac{1}{3}$, while the minimum is less by $\frac{1}{3}$ than the mean. The rainfall varies much over Scotland, the west coast being proverbially wet, while the east is comparatively dry. Rothesay, for instance, has an average rainfall of about 45 inches, while Aberdeen has one of about 27 inches; and even in small areas there are great diversities in the amounts, depending on some of the various conditions which determine rainfall. The practical deduction from these points is that actual measurements of the rainfall of any district for a series of years are necessary to determine with any exactitude its amount. Rain falling on the ground is disposed of in various ways; some evaporates and again passes into the air; some runs off from the surface and swells streams and rivers; the remainder sinks into the ground. While rain thus disappears in three separate forms, it by no means happens that these are in equal proportion, or have any proportionate relationship whatsoever, so that to say that $\frac{1}{3}$ of the rainfall is available for water supply is absurd.

We have dealt with evaporation, and now we have briefly to indicate the conditions affecting surface discharge and percolation of rainfall. Those two conditions are opposed to each other, as what favours the one is opposed to the other. Primarily we would assume that the larger the rainfall, the

greater quantity would sink into the soil; but this is not the case, even when conditions of soil are favourable to percolation.

Numerous experiments by gauges measuring percolation have been made, and their results doubtless are fairly correct; and the following results from Dalton's Gauge will show how percolation varies at different seasons of the year. Thus in winter, with a rainfall of 14·2 inches, there were 5·8 inches of percolation; while in summer, with a rainfall of 19·4 inches, there were only 2·6 inches of percolation. For the entire year, with a rainfall of 33·6 inches, a percolation of 8·4 inches occurred.

A most elaborate series of observations made on the Nash Hills, extending over a period of twenty-nine years, are quoted in the *Book of Health* by Messrs. Field and Peggs, and the following are abridged statements from these:—

	Maximum.	Minimum.	Average.
Winter, . .	16·36	2·69	8·11
Summer, .	18·82	0·00	2·18
Entire year, .	21·38	3·55	10·29

A heavy fall of rain may occur in summer and no percolation result; the ground being dry and porous, evaporation goes on freely under those circumstances, and vegetation, at this time active, absorbs a large proportion; while a slight fall in winter may give a large percolation. Sufficient has been stated to show how percolation varies with season.

Percolation influenced by Soil.—Some soils are nearly impervious to percolation, such as dense clay; while others, such as chalk, sand, and gravel, allow free percolation. Limestone allows about 20 per cent. to percolate; sandstone, 25; chalk, 40; loose sand, 60 to 90. The slope of the ground, as well as the permeability or impermeability, also influences percolation and surface discharge.

Discharge from surfaces, available rainfall ÷ total rainfall:—

Steep granite, schist, slate, . .	1
Steep pastures, ...	·6 to ·8
Flat cultivated soils, . . .	·4 to ·6
Chalk, ...	0

(Professor Rankine.)

All the various circumstances already described act together in determining what proportion of rainfall may become available for water supply; and not one alone should be taken, but collectively, and with due consideration of the manner in which they vary, according to the various determining causes.

Quantity of Water to be supplied.

The number of gallons per day which should be allowed for each person depends upon various circumstances, such as, if in a town, where there are W.C.'s used, and where allowances have to be made for town and trade purposes; or if a country village, where there are perhaps no W.C.'s, and no trades requiring an allowance of water. The following quantities for various purposes are usually allowed :—

	Gallons daily.
Cooking, . . .	·75
Fluids as drink, . .	·33
Ablution and sponge baths,	5
Share of utensil and house-washing, . . .	3
Share of clothes-washing,	3
Total for domestic purposes,	12
General baths, . .	4
Water-closets, . .	6
Waste, . . .	3
Total house supply, .	25
Town purposes, . .	5
Trade purposes, . .	5
Total,	35 gallons per head daily.

Quantities of Water allowed in various Towns.

Glasgow, . . .	50	gallons per day.
Edinburgh, . . .	35	„ „
Liverpool, . . .	30	„ „
Southampton, . . .	35	„ „

London average, . .	28	gallons per day.
Paris, ...	31	„ „
New York, . . .	300	„ „
Ancient Rome, . .	350	„ „

From this table it is seen how widely the quantities vary, and that none come up to the lavish quantity used in ancient Rome.

Generally it may be stated that 35 gallons per head is a liberal allowance for a town, and if there were no waste, less would be sufficient; but it is better to be over than under the above-mentioned quantity.

Rain-water as a Water Supply.—The greatest objection to rain as a supply is the uncertainty of its amount, and the very large reservoirs which would be needed for storage; still it is too often allowed to run waste. Rain as it leaves the clouds is very pure; but in its passage downwards it becomes altered in its composition. It absorbs gases from the air, and becomes highly aerated, as much as 32 per cent. of oxygen being often present, and of carbonic acid 3 per cent.; also the various salts of ammonia; chlorides, sulphates and their bases; the latter especially near manufacturing towns. Salts of lime are present, but in small proportion; hence rain-water is soft. The total solids are small, acting as it does as an air purifier; many other substances are found, including bacteria, and various plant forms of life. Rain-water becomes fouled by washing the surfaces on which it falls; and these may be very foul after long droughts from such matters as soot, tarry particles, dead leaves, etc. Buch's and Roberts' Percolators are useful for removing the suspended matters from rain-water, as by an ingenious arrangement the first quantity collected is thrown away. The amount of rain that falls on the roof of a house available for water supply may be calculated thus:—Area of *flat surface* covered by roof $\times$ 144 $\times$ rainfall $\div$ 277·274; or shortly, area in feet $\times$ rainfall $\times$ 0·52 = gallons. This does not allow for loss by waste or evaporation. It has been proposed to collect water on a specially prepared impervious surface, such as concrete. The above formulae would give the quantity available with the same errors as above; and 1 inch of rain on every acre = 22·617 gallons. The advantages of rain for water supply are its softness and com-

parative purity; but its softness and high aeration have a dangerous property in dissolving lead, zinc, and iron, so that cisterns or pipes of these are dangerous for storing or conveying rain-water.

Springs.—We have already somewhat fully indicated the conditions affecting evaporation and percolation, and how these determine the amount of rainfall which will pass into the soil and become indirectly available as a water supply. The depth which rain will sink into the ground will depend on the depth of the impermeable strata; water accumulates and renders these strata waterlogged to a point above which it will overflow and escape by a natural or made outlet. The direction will depend on the "dip" of the strata, and on the effect of "faults," which often divert water in an opposite direction. In mining operations the piercing of a "dyke" or "fault" often leads to a serious flood of water; but sometimes a fault is intentionally pierced to allow water to percolate away.

In the sections dealing with soil and subsoil water the latter was sufficiently explained, and its important relations must be directly associated with springs, as springs are just the outcropping of subsoil water with the strata in which they occur. Springs are usually divided into land springs and main springs, the former being those that flow from superficial beds of drift or gravel lying on an impervious stratum; while the latter are those found in chalk, sandstone, etc., at considerable depths. They are more constant than the former, and are purer, though harder, from the parts of the soil dissolved by the action of the water and its contained carbonic acid gas. This gas is in large proportion in soils, as formerly mentioned, and is absorbed by the rain-water in its passage downwards.

A most instructive diagram by Messrs. Field & Peggs (*Book of Health*) shows at a glance, from the year 1872 to 1881, the variation of depth of subsoil water, with rainfall and percolation. From this diagram it will be noticed that the greatest percolation takes place in winter, and hardly any in summer. The water level is highest early in February or March, and lowest in October or November, from which months it rises to the maximum. The rise takes place after the greatest percolation, with a short interval. The variation in the level of subsoil water is greatest in chalk formations, and in the sandstones it is small.

The surface of subsoil water is not level, but has a fall, increasing as it approaches its outlet. Springs usually give a pure water, but not invariably so, as sometimes they contain so much mineral matters as to render them unfit for water supply. And they may even be polluted by organic matter gaining access at the point where they issue from the ground; and special means, according to circumstances, must be taken to prevent this occurring. The quantity which a spring can give can be obtained by observing the time needed to fill a vessel of known capacity; or in the case where there is a considerable run of water, by forming a weir across the channel with a notch of a certain breadth, usually one foot. When great accuracy is needed, a thin sheet of metal with a notch in it is used.

The greatest care is needed to have the upper side of the top plank horizontal, and to have the seams caulked or puddled to ensure that all the water runs over the notch. A pile should be fixed at some part of the stream where "still" water is. This pile has a ledge on it, and is driven into the ground till the ledge is exactly horizontal with the top of the weir. The depth of water on the ledge can thus be easily measured by a foot-rule. The amount can then be got by tables for the purpose or by calculation.

$D = 214 \sqrt{H^3}$, where D is discharge in cubic feet per minute for weir 1 foot in width.

To obtain result in gallons $\times$ 6·23.

The water running over the weir should have a free fall, and not be "drowned," or another formula is needed.

Wells.—In the Report of the Rivers Commissioners, shallow wells and deep wells are referred to, and the former are considered dangerous as sources of water supply, while the latter are considered wholesome. Now the division of wells into these two classes is somewhat conflicting, as different authorities use those distinctions with entirely different meanings. In the Rivers Commissioners' Report, by shallow wells are meant those under 50 feet in depth, while deep wells are over 100 feet. Others again refer to shallow wells as those occurring in permeable soils, while deep are those in impermeable. It would be better to use some other classification, taking into account depth and permeability or impermeability of formation passed through in sinking the well. A shallow well may be as safe as a deep well over

50 feet, if sunk in impermeable strata; while a deep well, if in porous material, might be highly polluted. There are other varieties of wells which have to be referred to, such as artesian and tube wells.

Shallow Wells.—Many mansion-houses and villages derive their entire supply of water from shallow wells, and often are quite pure in the case of the former; but supplies to villages from such are considered dangerous. This arises from the abundant sources of pollution which are invariably to be found in most villages, from cesspools, ashpits, leaking sewers, and surface pollutions soaking into the ground. The distance through which those causes may act cannot be accurately determined, and does not depend on the mere depth of the well, but the nature and dip of strata above which or into which the wells are made, and the direction of *flow of the subsoil water*, and *the causes which lead to alteration of the latter*, such as lowering of the subsoil water by excessive pumping. One instance occurs to me where a superficial well was drained by a mine being sunk at a distance of about 1000 yards.

In many villages it is of everyday experience to find in a small area two shallow holes sunk in the ground; one is called a well, and the other is called a cesspool, though in their respective functions they might be interchangeable. The effect of distance between the source of pollution and the site of the well, of course, is great in the direction of diminishing the risk as the distance is increased. But no reliance can be placed on there being any fixed distance, according to the depth of well, beyond which it will not draw impurities. Neither can any reliance be placed on a well being situated at a higher level than a cesspool or other source of impurity; as the underground water does not necessarily follow the dip of the surface, and the effect of lowering the subsoil water leads to alteration of the direction of its flow, so that it may flow from instead of towards the source of pollution. Contamination may occur in another way; by means of subsoil water rising after a fall of rain and coming in contact with impurities, which are carried down with the subsequent fall of subsoil water.

In connection with pollution of wells, to understand clearly how this may occur we must bear in mind all the facts connected with subsoil water; its rising and falling, and its gravi-

tating downwards to its natural outlet. When a well is sunk down through the soil, it intercepts this river, as it might be called. An area of ground surrounding the well is drained, and this takes the form of an inverted cone with its lines converging to the apex of the cone at the bottom of the well; those nearest the centre of the cone being steepest, while as we recede from this centre the lines are becoming more and more horizontal. Those lines, of course, correspond to the "drainage" which occurs into the well, and as far as they extend pollution may be carried into the well. If the well is sunk deeper, or if the subsoil water is lowered by pumping, then we have an extension of those lines and increased risk of pollution. How far this depression may act can only be vaguely expressed. The following distances are given for different soils:—

Fine sands and gravels,	distance from	15 to 39	times depression.
Chalk with fissures,	,, ,,	57	,,
Coarse gravel,	,, ,,	68 to 160	,,

No dependence should be placed on these distances, as the danger of pollution is too great for reliance on such calculations.

To prevent or diminish to a great extent the pollution of waters by percolation through pervious soils into wells, whether deep or shallow, the following precautions are necessary:—The walls should be made of some impermeable materials, such as bricks set in cement and puddled with clay behind. This should extend from about a foot above the surface of the ground down to impervious strata; so that if polluting water soaks down, it will be tolerably well filtered before gaining admission to the well. The mouth of the well should be covered up by an iron or pavement cover. In shallow wells it is advisable to carry the clay puddle some distance round the mouth of the well. A pump is much safer and cleaner than a "draw" or "dip" well, and, of course, can be used to a depth of about 30 feet. Deep wells differ as already stated from superficial wells, either in being above 50 feet in depth, or being sunk in more or less impermeable soils. Deep wells are thus less liable to pollution than shallow ones, but usually have more mineral matter dissolved, and less aeration.

The effects of a tidal water on a well are to be taken into

consideration, and a good example of this is given in Chaumont's *Lectures*, p. 9. A well 83 feet deep, 140 above mean water-level, was 2,240 feet from the nearest part of a tidal river. By analyses it was found that the constituents varied at different times, depending on the action of the tide. Sewage poured into a stream may affect a well in the same way at a considerable distance.

According to Beardmore, wells may be classified into three:—

" *1st.* Those in which the depth is small, so as to catch only the adjacent percolating water, which may be expected to travel from the surface within a short period of time." In these the gathering ground is limited; but the depth being small, water soon gathers.

" *2nd.* When the depth is great through or into pervious strata, which have a more remote derivation of water, and whose power of drawing such water towards them is created by the depth given to the well and limited only by the friction of water through the strata. It is the element of friction, even in the most permeable strata, which gives a practical limitation to the supply of water to these wells."

" *3rd.* Those which are sunk into strata, which form the water-bed or absolute reservoir of water flowing from adjacent hills, and having impervious beds below, which uphold such subterranean streams."

Artesian Wells differ from ordinary wells in their relationship to the strata they are found in. Minerals assume often a basin-like arrangement, so that strata, on opposite sides, slope in opposite directions. Then suppose we have impervious strata, and below this pervious, and below this again impervious strata, in this intervening portion water is retained; and if a bore or well is sunk at the bottom of the basin through the first impervious strata, water is found under great hydraulic pressure, and will be forced up the bore or well to a height depending on the height of the water in the pervious strata. This may be sufficient to send the water many feet above the surface. In the Paris Basin, the Artesian system has been extensively carried out. At Grenelle there is a well 1,798 feet deep, fed by the rains which fall on the permeable strata of Champagne.

Tube Wells.—In these, tubes of wrought-iron of from $1\frac{1}{4}$ to 3 inches in diameter are used. The lowest tube is perforated at

the bottom for a length of 15 to 36 inches, and is furnished with a steel point slightly larger than the tube itself. The tubes are driven into the ground by a mallet or a "monkey" in the ordinary way of pile-driving. During the driving frequent trials are made to test for water or for earth which has gathered in the tube. The latter has to be removed by a rod for the purpose.

If the water is within 25 feet of the surface, a special form of pump is fitted on to the tube.

There is great risk of the tubes silting up with sand. The yield of wells may be ascertained by emptying, and the time noted which they require for filling.

Rivers and Streams.—The water supply from these may be pure or impure, according to circumstances. Too often the water is quite unfit for human use by sewage pollution, or by the pollution from agricultural districts, in the case of streams at least. Rivers, from their length and the variety of geological formations they pass through, are very varied in their composition, both as to mineral and gaseous constituents.

Streams usually take their origin from springs, or from gathering-ground, or both combined, and depend, as regards their composition, on the strata they arise from or flow over. When from such minerals as granitic trap, metamorphic, clay slate, millstone grit, and hard oolite, the waters are usually very pure, containing little or no organic matter; while if they arise from the lias clays, alluvial soils, or marshes, they may be very impure. The magnesian and limestone formations supply pure but hard waters. Streams as they flow on become augmented by the confluence of other streams, till they assume the dimensions of a river. The water in these may be quite pure, depending on the points noted in regard to streams and on the absence of sources of organic pollution, such as the drainage of highly cultivated soils or the sewage of villages or towns, with the contributing impurities from trades and manufactories. The volume of a river depends on the size and number of tributary streams, on its gathering-ground, the number and sizes of the watersheds, and the arrangement of the contour lines on these.

When impurities are discharged into a river, a process of self-purification takes place; the water is in constant motion, so that it becomes fully exposed to the oxygen of the air and to the

oxygen of the water, and the organic matter becomes oxidised into less dangerous forms; a certain quantity subsides to the bottom of the river and is thus got rid of, and may further be absorbed by the roots of growing vegetable forms, or taken as food by fish and minute animal forms. Pollution, however, may be so excessive as to bring purification by oxidation to a standstill, and subsidence be so great as to silt up the bed of the river. The organic matter uses up to a large extent the contained oxygen of the water, and carbonic acid appears in larger proportion. The oxygen is replenished by absorption from the air and by certain plants giving off this gas; but in such conditions the process of oxidation must be extremely small, and the organic matter, on which the organisms of putrefaction act, will be slowly resolved into its component parts with the evolution of offensive gases, so that the air over rivers and on their banks will become offensive and dangerous to the health of people dwelling near. Any one who has sailed down the Clyde or Thames on a summer day must have become sensible that self-purification has come to a standstill in these rivers, and that they are not only unfit for the supply of water for domestic purposes, but offensive and dangerous to health from the offensive gases given off. The large volume of water, in which the sewage mingles, dilutes it to a great extent; but during periods of drought, when the river is low, this diminishes to a proportionate degree. A question of the greatest importance is, whether by those processes of purification a river which has once been polluted by sewage can ever be fit to supply water for domestic uses. To answer this question, experiments have been made, in imitation of those that occur in a river, on water polluted with sewage. The mixture, which originally contained in 100,000 parts ·267 of organic carbon and ·081 of organic nitrogen, was found after 96 hours to contain ·250 organic carbon and ·058 organic nitrogen, and after 192 hours ·200 organic carbon and ·054 organic nitrogen. These results were got under conditions resembling the flow of a stream containing 10 per cent. of sewage for 9·6 and 192 miles respectively at the rate of one mile per hour. The conclusions derived from these experiments were, that oxidation of organic matter in sewage proceeds with excessive slowness, and that there is no river in the United Kingdom long enough to effect the destruction of sewage by oxidation.

Medical Reports on Water Supply by Rivers.

Medical evidence of much more significant importance than mere laboratory experiments, shows that the distribution of cholera in London was determined by the impurity of the water supplied at different points on the Thames. The evidence of the origin of typhoid, by the use of waters polluted with sewage matter, is equally convincing. The reports of the medical officers to the Local Government Board of England, and of medical officers of health in the United Kingdom, supply equally convincing information as to typhoid, cholera, diarrhœa, etc., being directly attributable to the use of sewage-polluted waters. It must be clearly kept in remembrance that the fæcal matter from cholera and typhoid cases contains the actual contagia of these diseases, and the most *apparently* insignificant quantity may be sufficient to start an epidemic after it once gets an introduction into the human intestinal canal. No other conclusion can be come to, in my opinion, than that a stream or river, if polluted with sewage to any appreciable extent, is unfit for the supply of water for the use of human beings, and that the self-purification that goes on should not be relied on. It must be stated that filtration has a great power of purification, and the experiments of Dr. Percy Frankland show that micro-organisms in waters can be reduced to as high a degree as 97·7 per cent. This shows a very high degree of filtration, which we must not invariably expect to find; but even the 2·3 per cent of micro-organisms, which escaped the filter in the above experiments, might be actual cholera or typhoid bacilli, and lead to an outbreak of these diseases. Certain authorities, however, come to the conclusion, that a flow of ten miles or so is sufficient to free a river from sewage pollution.

Upland Surface Waters.—The general characteristics of such waters have been indicated in connection with what has already been said in reference to springs, streams, and rivers. Usually the water is of the purest description, and large cities and villages are frequently supplied by gravitation from such sources, either from the water collected in natural lakes, such as Loch Katrine, which supplies one of the purest of waters, or by artificially-constructed reservoirs.

The question of upland surface water as a water supply is one

to be decided by the conjoint wisdom of the engineers, the chemist, the medical officer of health, and the population to be supplied, as represented by their councillors. It is one of the most important, as it is one of the most difficult, and should never be rushed into without full and lengthy inquiry by all those concerned with such an undertaking. Everything being considered satisfactory, the usual plan is to select some situation suitable for the construction of the impounding reservoir, such as a valley intervening between two hills, probably the basin of an extensive catchment area. Across this a dam is constructed, which may be of masonry, concrete, or an embankment of soil, sloped on either side at suitable angles, and with a core of puddle running through the centre of the embankment from side to side.

Great care has to be taken that this puddle core rests on a solid formation; and the soil has to be excavated until this is reached. This trench is then firmly puddled, and carried up with a breadth proportionate to the height and breadth of the embankment walls, and with a batter on both sides, so that the breadth of its base equals one-third of the depth of water in the reservoir. On each side of the puddle wall selected material is packed, and the inner slope is pitched with some impervious kind of stone. The total thickness and the pitch of the embankment walls will depend on the size of the reservoir, including, of course, its depth. Certain pipes have to pass from the reservoir, and they usually pass through the base of the embankment wall, though some engineers prefer to have a tunnel underneath or clear of it altogether. The pipes which have to pass from the reservoir are the service pipe or main, a supplemental service pipe of larger size, in case the water supply has to be increased, and a pipe to empty the reservoir when necessary. These may pass through the material of the embankment; but to prevent fracture of the pipes, or to obviate the serious danger of leakage between the pipes and the embankment walls, a built arch is often thrown across them. An overflow has also to be provided, which may be by a built channel at one end of the embankment, or by a tower of masonry in the reservoir, which may also act as valve tower for the regulation of the discharge from the various pipes. A gangway leads from the embankment to this. Sometimes a large upstand pipe is used instead

of a masonry tower, and water can be drawn from this at different levels, as may be desired. To carry away stream water or other excess of supply a bye-wash is provided usually, and this may lead into the overflow channel. Where the bottom of the reservoir is soft and boggy, this may have to be excavated, and all vegetable matter should be removed. Where the supply of water to the reservoir is deficient, it may be augmented by driving mines into suitable strata, by providing catch-water ditches, or by drainage of the soil by ordinary agricultural drains. Open catch-water ditches are highly objectionable in fields which are grazed by cattle or sheep, as in summer they find them cool places for their feet, and thus lead to pollution; besides, vegetable matter accumulates in them, and this is objectionable. It is better to increase the depth of a reservoir rather than its superficial area, as the shallow places produce rank vegetation, and become quagmires during the summer fall of the water in the reservoir. Theoretically, reservoirs should be covered over, but this is impossible—usually from the great expense. Filter-beds are sometimes constructed close to the reservoir, but not always, and the water may be conveyed to some convenient place, and then filtered before it is distributed. The subjects of filtration and distribution will be discussed farther on. The capacity of a reservoir must be determined by the number of people to be supplied, the number and kinds of trades and industries requiring water supply. A storage of from three to six months is generally allowed. To ascertain the cubic capacity of the reservoir, divide the total number of gallons needed daily by 6·23, and this multiplied by the number of days' storage will give the capacity needed in cubic feet.

Distribution of Water.

From the reservoir to the district to be supplied by gravitation various channels have to be provided. Frequently the water may be conveyed for part of the way in open channels, sometimes supported on mason-work when passing across a valley, in a tunnel when passing through a hill, and in an inclosed iron pipe where the force of gravity has to be overcome, and for this purpose the water must have a sufficient "head." The best material for the large pipes is cast-iron, and to prevent the action

of water on them should be eovered with Smith's varnish or barffed, by which the magnetic oxide of iron is produced on the surface. The supply may be either on the constant system, in which water is always in the pipes under pressure, and there is no need for much house storage, or on the intermittent system, where the water is not always in the pipes under pressure, and where storage is needed. The former is by far the better system, as it avoids the risks of pollution by storage, which are many; but this system requires stronger fittings, and without this much waste of water occurs. By the use of Deacon's waste-water meters, however, this waste can be detected and prevented; and in some towns there has been an immense saving to the consumers, as well as to the water suppliers, by those meters. A meter is placed on each district main, which shows the quantity of water flowing by night and day; as little or none is needed during late night, any flow is produced by leakages, which are localised by listening to the vibrations, and which can be heard by applying the ear to a pipe in any house nearest to the source of leakage. When the intermittent system is adopted, many dangers creep in, chiefly from storage. The water loses the character it originally possessed, both as to its aeration and coolness, besides acquiring polluting material. Sir John Simon in his Health Reports says: "I consider the system of intermittent water supply to be bad, not only because it is a system of stint, but from the necessity of storage. One constantly sees butts for the reception of water, dirty, mouldering, and coverless, receiving soot and all other impurities from the air, inviting filth from insects, vermin, sparrows, cats, children," etc. Whether water is supplied on the constant or intermittent system, eare should be taken that the pipe does not pass through sources of pollution, such as being laid in the same track as a sewer, or even to come near it in any way, as in both systems intermissions of supply do occur, a partial vacuum is produeed, and sewerage matter may be sucked into the pipe in this way, as oecurred at Caius College, Cambridge, Croydon, etc., and led to outbreaks of enteric fever. In mining districts this precaution as to the pipe track is of the utmost importanee, as leakages are constantly oecurring from drawn joints caused by subsidence, the minerals below being worked out, and sewage or other polluting matters (not necessarily from sewers) soaking into the pipe traek may be

aspirated into the water-pipe. Pipes should also be laid in the track at a depth of 3 or 4 feet, to protect them from both heat and frost. In the depressions in valleys, the mains are provided with flushing cocks, so that they can be emptied and cleared out, and at high levels air-valves are placed, to allow accumulated air to escape. Hydrants are also placed at convenient places for use in case of fire, or for flushing streets. Sewers should not be flushed by a pipe attached to the water main. The house communication pipe is usually made of lead, and this is attended with danger in the case of waters which have what is called a plumbo-solvent action. To obviate this various precautions are needed,—one good one being to use a block-tin pipe, with a lead casing, or the interior of the pipe may be coated with bituminous coating, coal tar, etc. The action of water on lead is so important, that a few remarks are necessary regarding it. The very purest waters act on lead. Thus Loch Katrine water—a pure, soft water—has a powerful solvent action; but a deposit of vegetable matter forms on the pipes, and no further action occurs. Waters highly aerated, such as rain-water, act powerfully on lead; and also waters charged with organic matter, or containing chlorides, nitrates or nitrites, mud, mortar, fruit, vegetables, etc. While waters containing carbonate or sulphate of lime, magnesia, and carbonic acid do not act much, as insoluble salts of lead form, and the pipe is protected from further action. It has been found that silica in water has a protecting action, unless there is much alkali in the water, and filtering waters through sand, flint, and limestone removes to a great extent this plumbo-solvent action. The presence of a free acid in some moorland waters leads to action on lead, but its exact nature has not been determined. Some think it hydrochloric, some sulphuric, and others that it is derived from peaty matters. There are other determining causes in connection with a plumbo-solvent action. Thus new lead pipes are more liable than old ones; bending the pipes against the grain, high pressure of water, and increase of temperature, all assist the solvent action. A galvanic action caused by the junction of a lead to an iron pipe is likewise a cause. Filtering the water through charcoal and broken limestone diminishes the plumbo-solvent action, and charcoal and spongy iron filters remove lead from waters that have become impregnated with it. The relationship

between plumbo-solvent action of waters and micro-organisms contained, is at present a matter for observation.

Storage in Houses.

In those cases where cisterns have to be provided, whether the constant or intermittent system of supply is adopted, care should be taken that they are not lead-lined, especially where soft waters are used. The best material for cisterns is slate, with cement joints or iron coated with the magnetic oxide or Smith's varnish. Zinc cisterns or pails are not desirable, from the action of waters on this material. Cisterns should be so placed in a house as to be easy of access for cleaning and repairs, and should be covered in to exclude dust, etc. Of course those used for drinking or cooking waters should not be used for W.C. purposes, but a special intervening cistern instead, such as a water waste-preventer. All sources of pollution already referred to in connection with W.C.'s and sewers must be carefully attended to.

The following recommendations as to water supply are given by Sir John Simon (*Public Health Reports*):—

1. That every house should be separately supplied with water; and that where the house is a lodging-house, or where the several floors are let as separate tenements, the supply of water should extend to each inhabited floor.

2. That in every court, at the point remotest from the sewer grating, there should be a standcock for the cleansing of the court.

3. That at all these points there should always and uninterruptedly be a sufficiency of water to fulfil all reasonable requirements of a population.

Regulations for Supply of Water by Companies.

In large towns often water supply is undertaken by water companies, and rules and regulations are usually made for their guidance, and to insure that the service will be satisfactory both to suppliers and consumers. The following extracts from the rules and regulations of a city for a water supply company are important:—

1. The company will at their own cost lay down and maintain

all the lead and other branches extending from their main to the side of the public highway in which such main is situate; and will, at their own cost, carry the pipe through the frontage wall (if there be one) and 6 inches beyond, or otherwise equivalently allow 15 inches in length for the owner's or occupier's plumber to connect his work to.

2. The owner or occupier must, at his own expense, lay down and maintain all the pipes and apparatus upon his premises or for his use, and of the strengths and descriptions, and subject to the rules following, that is to say,—

a. Such pipes must, unless otherwise agreed, be of lead, and of not less than the following weight, namely:—

Inch.	Lbs.
$\frac{3}{8}$,	5 per yard.
$\frac{1}{2}$,	7 ,,
$\frac{5}{8}$,	9 ,,
$\frac{3}{4}$,	11 ,,
1,	16 ,,
$1\frac{1}{4}$,	$22\frac{1}{2}$,,

b. The drawing (bib), stop, and ball cocks must be strong and of hard brass, and the better to secure water-tightness, of the kind from time to time sanctioned and approved by the company,

c. Every cistern must be absolutely water-tight, and be provided with a ball-cock, and proper means of access and inspection, but must not have an overflow or waste pipe; and if any such should exist, the same must be removed, or effectually and permanently closed before the water is turned on; but nevertheless as exceptional instances will occasionally occur in which it will be necessary to provide against the possibility of overfilling, the company will in such exceptional instances allow a detective or warning pipe to be attached to the cistern, provided that in every such case a written consent must be first obtained from the manager of the company, stating the fact of such consent and the position in which the detective or warning pipe must be fixed; and in every such case the work must be executed under the immediate superintendence of an officer of the company, and in the manner stated. On no account whatever can the water of the company be allowed to communicate with any

cistern or place intended or used for the reception of rain-water.

d. Every bath must be constructed without an overflow or waste pipe, and must be provided with a well fitted and perfectly water-tight apparatus, to prevent the water from flowing into and out of the bath at the same time.

e. No pipe must be laid through, in, or into any sough, drain, ashpit, manure hole, or other place, from which, in event of decay or injury to such pipe, the water of the company might be liable to become fouled, or to escape without observation, or without occasioning the necessity of immediate repair. In every case in which any such sough, drain, ashpit, manure hole, or other place as aforesaid shall be in the unavoidable course of the pipe, such pipe shall be passed through an exterior cast-iron pipe or box of sufficient length and strength to afford due protection to the water pipe, and to bring any leakage or waste within the means of easy detection.

f. Every pipe and apparatus laid and fixed by or for the use of the consumer must be inspected by an officer of the company before it is connected to the company's works ; and, if found not in accordance with the company's regulations, must be forthwith removed or altered.

3. The water supplied must not be allowed to run to waste, either wilfully or by neglect; nor must it be used for any other purpose, or to any greater extent, than shall have been agreed for.

4. No pipe must be attached to the works of the company, or to any pipe or apparatus connected therewith; nor must any alteration be made in any existing pipe or apparatus without due notice being given to, and the consent of the proper officer of the company being first obtained.

5. The supply and use of water for the purpose of trade and manufacture must be open to inspection and admeasurement whenever required; and such information must be from time to time afforded as will be sufficient to enable the company to obtain a satisfactory account of the quantity of water actually consumed, and of the pipes, cocks, cisterns, and other apparatus and conveniences for delivering, receiving, and using such water.

6. The company will, if and when so desired, execute all kinds of plumber's work connected with the supply of water to

their tenants; but are nevertheless desirous that the private business of the consumers of water shall be open to all the plumbers of the city. As, however, it is essential to the protection of the interest of the consumers, as well as of the company, that such work shall be well and soundly executed, and that the directors of the waterworks company shall possess a full and satisfactory knowledge of the state of the undertaking in all its departments, it is announced that no plumber or workman will be allowed to do or perform any work connected with the supply of water till he shall have been admitted, enrolled, and published by the directors as "an authorised waterworks plumber."

CHAPTER VII.

(SECT. XVI. SUBSECT. B.—*continued.*)

Purification of Water.

Water may be purified in many ways, but on a large scale we rely on the purification of water by passing it through various materials, by which a certain proportion of impurities is removed. This process of filtration may be performed either at the main reservoir or before the final delivery of waters to the consumers. Sometimes a settling-tank is used before filtering, in which a certain deposit of suspended matters takes place; but often the water passes directly from the reservoir into the filter or filters, as the case may be. It is better to have more than one, in case of accident, or for the purpose of cleansing (when one can be in use). The tank for the filter may be mason-work on concrete, faced with cement, the walls carefully puddled behind with clay. Along the bottom of this tank open jointed pipes are placed, leading into a main pipe, which usually passes into a clear water or storage tank, constructed to contain about two days' supply. Over these pipes the filtering material is placed, usually from 4 to 5 feet in thickness, and consisting of layers of fine sharp sand, gravel, and broken stones. The exact thickness of these is subject to great variations, but usually there is about 2 feet of sand for the top layer, then 6 inches or more of gravel, then at the bottom a layer of broken stones, measuring from about the size of potatoes to the size of turnips at the bottom. The sediment which deposits on the sand has to be scraped off from time to time, and fresh sand is added, or the old sand after having been thoroughly washed. The water delivered into the filter is regulated by a float and valve, acting usually in a special chamber; and there should never be more than a depth of 2 feet of water over the filtering medium. The superficial area of the filter should be so as to deliver about 70 gallons, or a little over, for every foot in twenty-four hours, though some engineers allow more;

but this should depend greatly on the water to be filtered. The speed of downward flow of the filtering water should not exceed 6 inches per hour. The clear water tank should be walled and roofed, to prevent impurities being introduced, to keep the water cool, and to prevent animalculae growing. By careful filtration a large proportion of suspended matters is removed, a certain proportion of dissolved mineral matters, and it is generally admitted a certain amount of organic matter is removed, probably by oxidation. It has been already pointed out that filtering certain waters through sand diminishes their action on lead to a great extent, and the number of micro-organisms are diminished to a very large extent by filtration through sand and gravel.

Filtration on a Household Scale.

There are very many varieties of filters in the market, and many varieties of filtering material used; but before entering into a discussion of these, it will be better to point out what are the conditions to be expected in a good domestic filter. The greatest of all the considerations is, that the filter should perform what it pretends to do, viz. to remove all, or nearly all, suspended matters, and a considerable proportion of dissolved mineral, and organic matter from water, and this within a reasonable space of time, as a filter may be very perfect in its purifying power, but useless from the time required for this purpose. Then the filter should add no impurity from any of its parts to the water, or give the filtered water anything which may favour the growth of animal or vegetable forms of life in the water. The filtering action should be reasonably lasting, without having to renew or change the filtering medium. Simplicity of construction, so that all parts of the filter are easily got at for cleansing or renewal, is a most important condition. It should always be borne in mind that no filter, however nearly it comes up to those desiderata, can do so indefinitely, and without careful attention, cleansing, or renewal of the filtering material from time to time. As already stated, there are very many substances in use as filtering media, such as sponges, asbestos, animal and vegetable charcoal, sand and gravel, spongy iron, carferal, magnetic carbide of iron, earthenware cylinders, etc.

Charcoal Filters, in which the medium is either animal or vegetable charcoal, have long been in use, and possess many

advantages, with a few disadvantages. Animal charcoal is preferable, and is prepared by calcining crushed bones in closed vessels, with the exclusion of air. Animal charcoal has a great purifying influence, not only by straining, but, from the large quantity of oxygen contained in its pores, by oxidation of the organic matter in waters. Its disadvantages are, that water after filtering does not keep; and that organisms develop in it, probably from phosphates being added to the water. Dr. Percy Frankland's experiments show, that the complete removal of micro-organisms from water by filtration is impossible without *frequent removal of the best filtering matters* and duly restricting the rate of filtration; and practical experience has shown that whatever form of charcoal is used, frequent removal is necessary. In the class of charcoal filters, the following are good examples: Lipscombe's Self-cleansing Charcoal Filter, Silicated Carbon Filter, Patent Moulded Carbon Filter. Crease's Filter, extensively used in the army and navy, is recommendable, as it can easily be taken to pieces, cleaned, and parts renewed. To clean charcoal thoroughly it must be roasted in a closed vessel, and then washed with distilled or very pure water. If this cannot be done, it should be boiled with dilute Condy's fluid and a little weak hydrochloric acid, exposed to the air and sun, and then pure water passed through it in large quantity. Cleansing should be done every three months, or oftener when impure waters are being filtered. Spongy iron filters fulfil more of the conditions wished in a good filter than any others. The substance is prepared by roasting hematite iron ores. Its action is both mechanical and chemical, and thus removes organic matter to a great extent. By decomposing water, hydrogen is liberated, the organic matter is then acted on by the oxygen. One objection has to be noted, that iron is added to the water filtered; but this can be removed by further filtration through sand and pyrolusite. Water filtered thus possesses none of the disadvantages attributable to filtration through charcoal, and renewal of the filtering material once a year is alone necessary. The spongy iron should always be kept under water, as it will cake and harden. Another form is the Magnetic Carbide Filter, the material in this being hematite heated with sawdust, and, when used with sand, is one of the best forms of filters, having, in addition to an extensive straining action, an active power of oxidation.

Carferal Filters.—The exact preparation of this substance is kept a secret, but it is believed to consist of iron, charcoal, and clay (Car. Fer. Al.). Filters with this substance resemble in their action the various iron filters mentioned, and are strongly recommended. Carferal can be purified by exposure to a low red heat, and then used again, or renewed once a year.

Asbestos and Charcoal. — The best example of this is the "Filtré Rapide" of Maignen, in which a layer of asbestos cloth is stretched over a frame, and charcoal or other additional substance spread over this. The filtering media can be purified by heating to redness, and renewal of the material is both easy and cheap, both of which are strong recommendations.

Pasteur - Chamberland Filter. — This form of filter is most applicable for laboratory purposes rather than as a domestic filter. Water is forced by pressure through a series of hollow earthenware cylinders, and in its passage micro-organisms and their spores are retained. From experiments of my own I have found it acts thus most efficiently. Of course ordinary suspended matters are also removed.

Purification without Filtration.

Distillation.—This form of purification gives absolute security, even to the most polluted waters, as everything is left behind except a little ammonia, which can do no harm. At sea, distillation has often to be resorted to, and by subsequent agitation of the water to give it aeration it is improved. The water should be stored in wooden casks, or glass-lined cisterns, not in lead, zinc, or iron vessels, nor brought into contact with such metals in distillation.

Boiling is not so efficient a means of purification as distillation, but the water retains its mineral ingredients and is better aerated. Gases which are highly objectionable are drawn off, such as sulphuretted hydrogen, and micro-organisms are sterilised, also their spores by *repeated boilings.*

By carbonic acid being drawn off by boiling, water is softened, as chalk, being thus rendered insoluble, subsides. Iron and organic matter are in part removed.

Exposure to the Air.—This goes on in nature, when waters subside and filter through the soil; streams and rivers in their movements become freely exposed to the air; oxidation of organic matter

and increased aeration ensue. Water falling from a height through a sieve is thus improved, or on a small scale, by free agitation in a barrel. This is advisable in waters which have been boiled or distilled.

Addition of Chemical Agents.—Hardness of water, when above a certain degree, is objectionable, and when due to carbonate of lime (causing temporary hardness) may be got rid of by boiling, as already mentioned, and also by the addition of lime-water (Clarke's patent). The lime combines with the carbonic acid, carbonate of lime is rendered insoluble, and is deposited. This can be got rid of by filtration through cloths, as in the "Porter-Clarke" process. In this process of softening, organic matter in suspension and a small proportion in solution are thrown down.

Amongst other purifying agents may simply be mentioned alum, bicarbonate of soda, permanganate of potash (Condy's fluid), and perchloride of iron. By the addition of these substances to water a certain amount of purification takes place, but quite unreliable to purify a water so as to render it safe for use.

Sanitary Importance of Water.

Water is one of the prime necessaries of life; without it we could live only for a short time, and when deficient in quantity or quality, there can neither be decency, comfort, nor health. In the whole field of hygiene there is no more abundant proof than of the causal relationship between disease and defective water supply. And some of these diseases are of the most deadly of all that afflict mankind. As examples may be mentioned cholera, enteric fever, dysentery, and malarial fevers, and these are only a few out of many. In Sir John Simon's *Public Health Reports* the following passages occur in reference to defective water supply: "The doctrine, in general terms, that a vast influence is exercised over the health of communities by the quality which they consume, is one which, as far back in literature as any reference to such questions could be expected to exist, may be seen to have universal medical consent in its favour. Not only is it now certain that the faulty public water supply of a town may be the essential cause of the most terrible epidemic outbreaks of cholera, typhoid fever, and other allied disorders, but some doubts are entertained widely whether these diseases, or

some of them, can possibly attain general prevalence in a town, except where the faulty water supply develop them."

While impure water may be the actual cause of such important diseases as cholera and typhoid fever, there are many other diseases attributable to impure water, and, although not of themselves deadly, produce an extensive amount of human suffering, such, for instance, as disorders of the digestive and alimentary system generally, including dyspepsia and diarrhœa. Space will not permit this subject being treated as fully as its importance demands, and it will only be possible to refer to the various diseases attributed to water causation, without entering into the proof of the matter.

Effects of defective Supply.—It is not easy to say how wide are the effects of a defective supply, as these are of indirect consequence. For purposes of cleanliness of person, house, and clothing, an abundant supply of water is necessary; and when it falls short, cleanliness suffers and filth increases, with all its concomitant evils. Even if there was no other evil than defective flushing of sewers, scarcity of water would be a serious evil.

Effects of suspended Mineral Matters. — Diarrhœa may be caused by waters containing an excess of such matters as clay, marl, and mica.

Dissolved Mineral.—The effect of carbonate of lime is not injurious, but sulphates, nitrates of lime, and magnesia cause diarrhœa, as also waters containing chlorides of lime and magnesia. Goitre has been associated in its causation with the use of waters containing carbonates and sulphates of lime and magnesia, but there are doubtless other causes at work.

Metallic Impurities.—Plumbism is frequently caused by the use of waters containing lead. How this may find its way into waters has, however, been already explained. Copper, iron, etc., may in like manner produce symptoms of poisoning.

Suspended Vegetable Matter.—It is not desirable that a water should contain much suspended vegetable matter, as diarrhœa may be caused; and this is also applicable to dissolved vegetable matter.

Suspended Animal Matter.—Human fæcal is of all the most dangerous form of pollution, and the presence of such should preclude any water being used for drinking purposes. But we

know how many river waters used for water supply are thus polluted. Waters thus polluted are specially liable to favour the outbreak of cholera and enteric fever. The water derived from graveyards is liable to pollution by dissolved animal matters, and such waters are generally bright and sparkling.

Waters polluted by sewer gas, common gas, and sulphuretted hydrogen are not fit for use.

Diseases specially associated with Organic Pollution of Water.

Cholera, one of the most deadly, as often one of the most widely diffused of epidemics, is intimately connected with waters thus polluted, which cause, in the first instance, an increased susceptibility of the individuals to be attacked; and secondly, the water thus polluted acts as the breeding ground for the virus of the disease. When drinking water once becomes infected with the evacuations—in which the contagion is found—of a person suffering from cholera, it is easy to see how widespread the influence of water so polluted may become. The evidence on the origin of cholera in this manner is most extensive.

Typhoid Fever has the same connection with polluted water as cholera, and the introduction and subsequent multiplication of the organisms in a water are the factors necessary for the outbreak of typhoid fever.

Dysentery is associated with impure waters; but probably, as in the cases of cholera and typhoid, pollution of the water by the dysenteric evacuations is necessary.

Malarial Diseases are directly caused by drinking waters which contain the contagion of such diseases.

Water specifically polluted.

Some of the parasites that affect the human body gain admission by means of water. Round worms (*Ascaris lumbricoides*), *Distoma hepaticum*, *Oxyuris vermicularis*, *Bothriocephalus latus*, and *Tænia solium* thus are introdueed either as eggs or embryos.

Powers and Duties of Local Authorities as regards Water Supply.

In discussing the subject of sewerage and drainage, we described the process which has to be gone through when any

ten inhabitants of a district petition the Local Authority for the formation of a special drainage district. In the case of the formation of a special water supply district, the same process is necessary. In defining a village for forming a special water district, the boundaries of the village must be in some manner defined, and the resolution of the Local Authority must specify the limits of the proposed district, and the whole resolution must be published in the newspapers. It is not necessary that those signing the petition should reside within the proposed special water district.

According to section LXXXIX. clause VI., it is lawful for the Local Authority to borrow, for the purpose of constructing, purchasing, enlarging, or reconstructing such works as are authorised for providing a supply of water.

For the purchase of lands otherwise than by agreement, and before putting in force any of the Lands Clauses Acts, a certain procedure has to be gone through which is detailed in section XC. of the Act, and has been referred to in chapter I. of this work.

As in the case of providing sewerage and drainage systems, two or more Local Authorities may combine for this purpose. In the case of sewers, consent of the Board of Supervision is necessary. It cannot be too strongly recommended, that by such combinations of districts a much better and cheaper scheme can be carried out, and, in fact, without such combination districts are often left in most deplorably insanitary conditions, from the expense that would fall on one district acting singly, when by combination the cost would not be at all serious.

In burghs with a population at last census of 10,000 or upwards, or having a Police Act of their own, the Local Authority may contract or arrange with any water company, established by Act of Parliament for the supply of water, or themselves, to provide a supply of water where there is no company (section LXXXVIII.).

In the case of burghs with a population under 10,000, and not having a Police Act, and in parishes, the Local Authority may acquire and provide or arrange for a supply of water, and do all the necessary things for obtaining water, such as making wells, reservoirs, laying pipes, etc., or they may contract with a water company. Where there is a water company established

by Act of Parliament, the Local Authority must purchase or acquire the undertaking, if they wish to supply water themselves.

The Local Authority can compel the owner of a house without a proper supply of water at or near it, to obtain such a supply. But as there is no defined distance, the Sheriff has the power to decide in case of dispute. Common lodging-houses without a proper supply of water may be removed from the register until a supply is obtained. The Local Authority have power to supply any surplus water for baths and wash-houses, or for trading and manufacturing purposes, on such terms as may be agreed upon. It is not legal to charge both for the supply and the special water assessment, but one or other.

All existing public cisterns, pumps, wells, reservoirs, conduits, and works for the free supply of water to the inhabitants, may be supplied with water by the Local Authority, and they may provide gratuitously water for any public baths or wash-houses, other than for private profit, or supported out of any burgh rates.

The Local Authority may borrow money for water supply purposes.

Under section XXVII. of the Act, a severe penalty may be imposed for the fouling of water used for domestic purposes. Thus it is there stated: "Any person engaged in the manufacture of gas, naphtha, paraffin, or dye-stuffs, or any other deleterious substance, or in any trade in which the refuse produced in any such manufacture is used, who shall at any time cause, or suffer to be brought, or to flow into any water used for domestic purposes, any product, washing, or other substance produced in such manufacture, or wilfully do any act to pollute any such water, shall forfeit for every such offence a sum not exceeding £50. Such penalty to be sued for within six months by the Local Authority, or by the person whose well or other water source has been fouled. The Local Authority must give notice to the person injured of their intention to proceed for the penalty."

In addition to the above penalty, after twenty-four hours' notice by the Local Authority or person aggrieved, of such offence being committed, the defaulter is liable to a fine of £5

per day for every day during which the pollution continues, and such penalty shall be paid to the Local Authority or person by whom the notice was given. After payment of the damage, the Local Authority may apply the balance towards defraying the expenses of executing this Act.

The powers which a Local Authority have as regards nuisances generally under subsection (B) of section XVI. of the Act, are the same as in subsection (A). For the non-compliance with a decree to abate or remove a nuisance, a daily penalty of ten shillings or under, and for knowingly to infringe any interdict, a daily fine of twenty shillings or under are incurred. A sheriff, magistrate, or justice may order structural works for the removal or remedy of a nuisance; and the Local Authority may be empowered, by sheriff or justice, to carry out all necessary works, if the owner fails to do so, or cannot be found. All expenses to be recovered from the author of the nuisance.

No. 6.—*Notice by the Local Authority to the Person by whom any Product produced in the Manufacture of Gas or other substance is caused or permitted to flow into any Well, etc., sects. 27 and 29.*

NOTICE.

The Local Authority of hereby give notice to you , that you have caused or suffered, and are now causing and suffering, or other substance produced in the manufacture of to flow into [stream, well, etc., at constructed for the supply of water for domestic purposes; *or*, which is used for the supply of water for domestic purposes, etc.], or into a pipe or drain communicating therewith; also that you have wilfully done an act connected with the said manufacture in which you are engaged, viz. [*state the act,*] whereby the water in the said is fouled; also, that you the said have wilfully done or permitted to be done, viz. [*state the act*] whereby the water in the said is fouled; and that you are liable in the penalty of a sum not exceeding £50, under sect. 27 of the Public Health (Scotland) Act, 1867, and that you will further be liable, under sect. 29 of the said Act, to forfeit a sum not exceeding £5 for each day during which such substance shall be brought or shall flow as aforesaid, or during which the act by which water shall be fouled shall continue after the expiration of twenty-four hours from the time when this notice shall have been served upon you.

This notice served on the day of at o'clock .M.

Sanitary Inspector.

CERTIFICATE OF SERVICE.

I, , certify that I served a notice, of which the foregoing is a copy, on therein mentioned, on the day of at o'clock .M., by [*state mode of service; as*, by putting the same into the Post Office at addressed (*give address, etc.*)], in presence of the undersigned witness.

, *witness.*

No. 7.—*Notice as to Penalty for Polluting Water, sects.* 27, 28, *and* 29.

Notice by the Local Authority of to as to water belonging to him being fouled, etc.

The Local Authority of hereby, in terms of sect. 28 of the Public Health (Scotland) Act, 1867, give you notice that they intend to proceed against for the penalties provided by the said Act, sects. 27, 28, and 29, incurred by him for contravention of sects. 27 and 29 of the said Act, in regard to the [well, stream, etc.] belonging to you, unless you shall, within days after the serving of this notice, proceed to recover the said penalties.

This notice is given on the day of at o'clock .M.

Sanitary Inspector.

CERTIFICATE OF SERVICE.

I, , certify that I served a notice, of which the foregoing is a copy, on therein mentioned, on the day of at o'clock, by [*state mode of service*] in presence of the undersigned witness, viz.

, *witness.*

CHAPTER VIII.

SANITARY EXAMINATION OF WATER.

In cases involving any dispute, or in other cases where it is most important to get a thoroughly accurate chemical analysis of a water, it is not desirable that the medical officer of health should undertake the difficult and highly technical operation himself, but the trained chemical analyst should then be relied on. At the same time, it is most desirable that the medical officer should be able not only to interpret the results of the chemical analyst, but to make preliminary tests of drinking waters himself. Frequently a preliminary examination will be sufficient to condemn a water, and there would be no further need for a complete analysis; but in doubtful or difficult cases this preliminary examination should be followed by the complete process of the water analyst. In the following pages a brief account will be given of certain tests which every medical officer of health should be able to perform for himself, and, with practice, attain considerable dexterity in the operations.

Physical Examination of Water.

Smell.—For this purpose the water is put into a corked or stoppered bottle, then shaken thoroughly, and then smelt; the degree and kind of smell, if any, should be noted. If no smell is felt, the water should be heated and again smelt. A putrid odour indicates decomposing animal or vegetable matters; if there is fresh sewage matter present, a urinous smell may be found. The absence of smell is only a negative test.

Colour.—To test this, the sample of water should be put in a 2-feet tube of about 2 inches in diameter, closed at the ends with plate glass, and having a hole at the side to introduce the water by. The tube is half filled with water, and then directed towards a white surface, and the test compared with the air—the space above the surface of the water. Another way is to

quite fill the tube, and compare the colour with that of another tube alongside, filled with pure distilled water.

Perfectly pure water is bluish, but ordinary waters may be greyish, greenish, or even brownish as in mossy waters. The clearness of water is determined in the same way as the colour. After the water has been shaken up, marked turbidity should be carefully inquired into, and may depend on imperfect filtration.

Taste.—This is an uncertain test; according to experiments by De Chaumont, the following substances can be tasted when their proportions occur as given below:—

Sodium Chloride	is tasted	when it reaches	75	grains	per gallon.
Potassium	„	„	20	„	„
Magnesium	„	„	50 to 55	„	„
Calcium Sulphate	„	„	25 to 30	„	„
Sodium Carbonate	„	„	60 to 65	„	„
Iron	„	„	·2	„	„

It will be seen that many substances may exist in large proportions in water and not be detected by tasting.

Microscopical Examination.

This process may be directed to examination of (*a*) suspended matters, (*b*) sediment.

(*a*) To examine suspended matters, a drop should be transferred to a glass slide, covered over with a " cover " glass, and examined under both low and high powers of the microscope (250 to 1000 diameters).

(*b*) To collect the sediment, the water should be placed in a tall conical glass, covered over with a piece of paper, and then placed under a glass bell jar to stand for a few hours. The sediment may then be gently sucked up by a pipette, and a drop transferred to a microscope slide. A method for collecting sediment is described in Winter Blythe's work on water analysis. A tall glass tube, capable of holding about a litre of water, is used; the lower end is drawn out to a pipette-like point, over which a glass cell is placed, and which is removed after twenty-four hours, when a deposit will be found suitable for microscopic examination.

The variety of substances found by microscopic examination

will be both numerous and conflicting, comprising mineral, vegetable, and animal matters, animate and inanimate.

The living matter is the most important, and we may find all varieties of micro-organisms — fungi, algæ, diatoms, desmids, englenæ, paramecia, hydrozoa, worms, and their eggs. As already mentioned, the numbers and varieties found are conflicting, and reference should be made to the plates in Parkes' *Hygiene*, and to those in Macdonald's *Guide to the Microscopical Examination of Drinking Water.* The biological examination of drinking water has assumed much greater importance by the introduction of Koch's process for cultivating the micro-organisms in water, and it is necessary to refer somewhat fully to this method of examination.

The process cannot be described briefly. To be of any service it must be done scientifically, and requires strict attention to minute details. Nutrient gelatine can be procured now-a-days from laboratories and scientific apparatus providers; but those who wish to make it can do so by following the details given below:—

Preparation of Nutrient Jelly.—Two pounds of lean beef are finely minced, and to this are added 2 litres of distilled water. These are stirred together, and then allowed to stand for twenty-four hours in a cool place. The fat is then skimmed off, and the residue is poured into the cavity of a serum press lined with a fine cotton cloth, through which the liquid has to be strained and then collected in a large glass flask. The mass of meat left is closely wrapped in the piece of cloth, and by repeated pressure all the remaining juice is squeezed out. By this means a red broth is obtained, which should measure about 2 litres; if less, distilled water is added to the solid residue in the cloth. The moisture is then expressed and added to make up 2 litres.

Put the 2 litres of broth into a 4-litre flask, and add to it 100 grammes of best table gelatine, 100 grammes of albumen peptones, and 5 grammes of common salt. The gelatine should be of the best French variety (blue and gold label).

The gelatine mixture is now stirred and its reaction tested, which is usually acid. It must be made neutral, and for this is added a saturated solution of carbonate or alkaline phosphate of soda. The reaction is tested by red and blue litmus, adding the alkali slowly until an exactly similar tint is got on each paper

immersed in the liquid. As soon as the liquid is neutral, the flask is plugged with sterilised wool and placed in a steam steriliser, where it is steamed for half an hour, then removed to a cool place till the next day, when it is again steamed for half an hour. It is tested at this time, and if acid, alkali is added till it becomes neutral, or slightly alkaline. While still liquid, the broth is filtered through a coarse filter paper in a heated filter, and for that purpose the paper is first washed with distilled water, and the jelly first filtered is reserved for a second filtration. During filtration the filter is covered with a glass plate or bell. The filtrate is received into a sterile flask, and stoppered with a sterile cotton-wool plug. The flasks, $\frac{1}{4}$ litre, are thoroughly washed out, dried, and then plugged with cotton-wool, and placed in the hot-air chamber at a temperature of 170° C. for an hour or so. The plug is then removed from one of them, and held with catch forceps, so that it touches no other thing, its lower end being held downwards. The flask is placed below the filter, and the jelly allowed to run in till it is nearly quarter full. It is then quickly plugged, and other flasks put under the filter till the material is exhausted. The flasks are then steamed in the steamer for twenty minutes. If the jelly is not perfectly clear, it must be refiltered or clarified with egg albumen. At the end of the third day's steaming the gelatine broth is placed once more in a cold place for twenty-four hours, and on the fourth and fifth days it is steamed for fifteen minutes, and allowed to stand in a cool place during the interval. The process is now complete.

There are other varieties of solid media, but for which reference must be made to the works of Klein and Crookshank. In warm weather it is necessary sometimes to use an agar-agar peptone jelly, as the agar-agar remains solid to a temperature of about 45° C.; the agar takes the place of the gelatine mentioned in the former preparation.

Method of filling Test Tubes. — These must have been thoroughly cleansed by washing, dried, then plugged with cotton-wool plugs, finally heated in the hot-air chamber for an hour at a temperature of 170° C. When cool they are charged with the contents of the flasks (stock flasks, as they are called), which have been liquefied by heating. A filtrate is sterilised by heating as the tubes were, and 10 c.c. are drawn from one of the stock flasks and introduced into a test tube (the plug having been

twisted out), not allowing the gelatine to run down the sides of the tube; the tube is then firmly plugged, and allowed to stand upright till the jelly solidifies. The tubes may be again heated for several successive days, for an hour at 170° C., to be sure that there is no possibility of anything capable of living being amongst the jelly. After having been kept under observation for a week and no change appearing, we may be sure that there is complete sterilisation.

Preparation of Bread Paste. — Remove the crust from stale bread and dry in an oven. Break up and powder in a mortar. Clean and sterilise small flasks plugged with cotton-wool; a small quantity of the powder is placed in them, and sterilised water in the proportion of 1 to 4 of bread is added. Plug, then steam for three successive days, at 100° C., for half an hour.

Those flasks with the contained paste are useful for inoculations, and the growth on the surface stands out in clear relief against the white bread as a background.

Glass Apparatus needed. — Glass plates of ordinary kind, 4″ × 5″, pipettes for dropping water. It is well to use the same one, but in cases of breakage a number is needed.

Glass rods armed with platinum wires for spreading the nutrient jelly over the glass plates, and for making inoculations.

Glass slides and cover glasses for microscopic examination, test-tubes, small glass jars, watch glasses, large squares of plate glass, say 15 inches square. These are needed for placing the small glass squares on, a sheet of filter paper, soaked in bichloride solution placed over the plate glass.

Bottles for collecting Samples of Water.—As only a small quantity is needed, small bottles, with glass stoppers, are sufficient. For conveyance by post or otherwise I had a case made by Hume, Edinburgh, to hold two, and two tubes with nutrient jelly if wished. This could be sent by post without risk to bottles enclosed.

Small Glass Funnels.—For filtering dyes, a piece of filter paper is made into a filter in the usual manner to fit into the glass funnel.

Glass Bottles for distilled water and solution of corrosive sublimate. For distilled water a good plan is to have a bottle with a tap at the bottom, and a cotton-wool plug at the top, which, of course, filters the air before entering the bottle. A glass plate

ruled into squares, and black on one side for counting colonies on plates, is needed.

Bell Jars.—Ordinary shallow jars are used, either with knobs or without. In the former the upper fits into the under, whereas in the flat form used the upper fits over the under. From a half to a whole dozen are needed.

Levelling Surface. — It is recommended to use a levelling tripod, which by screw adjustment gives a true level ; but if you have a table with a level surface, and use a plate-glass square for the glass squares to rest on, this is sufficient. When you use the tripod you place the plate glass on it, and by means of a small circular spirit-level find out when the surface is exactly level, adjusting the screws on the tripod till this point is reached.

The above description has referred to the various apparatus needed, and in the following the whole process of making "plate cultivations" will be described.

Method for Plate Cultivations.

Water, to be examined biologically, need only be procured in a very small quantity, and great care must be taken to keep out accidental sources of contamination. The collection bottle should be sterilised in the hot-air oven for an hour at 170° C., and then the stopper, also sterilised, inserted. When filling the bottle with the sample, invert it if possible, and then withdraw the stopper under water, reinserting it when the bottle is filled. The small squares of glass, and the pipette used for dropping the water, should be sterilised in the same way as the bottle, and allowed to cool. A large plate glass is then placed on the levelling stand, or on any level surface, and a piece of bibulous paper soaked in 1 to 1,000 solution of bichloride of mercury. The bell jars to be used should either be sterilised in the hot-air oven, or by rinsing out with the bichloride solution (taking care no drops collect inside). The bell jars and plate glass should be prepared and ready for use about twenty-four hours before they are needed, as dust takes a long time to settle, and contaminations may arise in this way.

A test tube with nutrient jelly is then taken, and the jelly liquefied by heating. It is now ready for the introduction of the water to be examined, and for this purpose insert the pipette into

the sample bottle, allowing two or three c.c. to enter. Remove the cotton-wool plug from the jelly tube by screwing it out, and hold it between two fingers, with rough end uppermost, then cautiously drop, say five drops of water into the jelly, and reinsert the cotton-wool plug. In impure waters five drops will be too large a quantity, and one might be sufficient. The water is then distributed through the jelly by rolling the tube round its long axis.

A rod with a platinum wire attached will then be needed, after it has been heated to redness in a flame, and afterwards allowed to cool, taking care not to bring it in contact with any source of contamination while so cooling.

The jelly must now be poured over the surface of one of the small glass squares, which may be taken out of the oven for that purpose at this time (or better if it has been previously sterilised) and placed on to the large plate glass, with the bibulous paper, previously described, and covered up with a bell jar, as already mentioned.

If the plate is covered, as in the latter case, the edge of the bell jar should just be raised high enough to allow the jelly to be poured on the plate, and then, by means of the platinum wire, the jelly is equally distributed over the surface of the glass square as quickly as possible, and the bell jar replaced. The jar should then be labelled with some distinctive mark,—with the date on which the cultivation was begun. It should be kept at a moderate temperature for several days, when little points or "colonies" will appear on the surface of the jelly. After keeping the cultivation for a sufficiently long time,—usually four or five days are enough,—it is ready for examination.

Examination of Cultivation.—Count number of points or colonies by placing the plate over another glass plate with ruled squares. Note if any points are liquid, and mark down in notes the general appearance of the growths. Examine by a lens especially any point you may be doubtful of, whether it is a colony or a speck of dust, or a flaw in the glass; by the low power you can determine the colour better than by the eye alone. A good hand-glass is useful for enumerating the colonies. The next process is to make cover glass preparations or inoculations, or both, especially when you think there is something of special interest. For the ordinary purpose of water analysis, I fear

inoculations and subsequent cultivations take longer time than can be given for that purpose.

Before making cover-glass preparations, great care must be taken to see that all glass shades, cover glasses, etc., have been carefully cleansed.

Select a point you wish to examine, take one of your rods armed with platinum wire, pick up the point and transfer to a slide or cover glass. At this stage you may wish to make an inoculation, and there will be sufficient adhering to needle for this purpose. The method will be described later on. Place another cover glass over the transferred point, and squeeze the one cover glass against the other or against the slide, slide the one over the other till a very thin layer is got, and then separate them by squeezing the one over the other. Catch hold of the cover glass with platinum-pointed forceps, and pass it through the flame of Bunsen burner or spirit lamp three or four times, as slowly as you cut bread. The side with the deposit must be uppermost, and after this, and in this position, place it on a sheet of blotting paper; drop through paper filter in glass funnel a couple of drops of the stain you wish, and allow them to remain with a watch glass over the cover glass from two or three to ten minutes, according to the strength of your staining fluid. Then lift again with forceps and wash off the stain with a wash bottle; the more thoroughly this is done, the better preparation do you get. Allow the slide to dry by putting it on its edge against a rest, and resting on blotting paper. After it has thoroughly dried it is ready for mounting, and for this purpose drop balsam or glycerine as you wish on to a glass slide, place the cover glass over, resting one side on the slide, the opposite supported with your forceps, allow it to fall, and press gently but firmly down. Label the slide and place it aside till the mounting dries, when it will be ready for microscopic examination.

Method of Inoculation with Nutrient Jelly or Bread Paste.—Overheat the platinum needle, and pass the rod as well, slowly through the flame and let it cool, not touching anything which would contaminate the wire or upper or lower portion of rod. Screw out plug from jelly tube (the tube inverted), hold plug between two fingers, smooth end downwards, pick up a colony or portion of one, and insert deeply into jelly or bread paste, withdraw the rod, and then reinsert plug. Label the tube or flask with

name, source, date, etc. The tube can then be placed in a rack for the purpose, and either in an incubation chamber or kept at ordinary temperature.

It is hoped that this somewhat extensive reference to the "plate cultivation" method of water analysis will not be out of place, as from an extensive experience the writer found that the test properly applied is a valuable adjunct to chemical methods; and, further, any one wishing to perform the method will have difficulty in finding a short description of it, the various parts of the method being scattered over text-books on Bacteria. These reasons led me to insert the foregoing description of the process.

Chemical Methods.

The examination of a water with reference to its fitness for human use often comes within the scope of the duties of a medical officer, and this examination may be merely to ascertain if certain substances are present, without determining their actual amount, such an examination is then called a Qualitative Analysis; or the examination may at the same time ascertain the quantities of this substance, and it is then called Quantitative. It seems to me desirable that the latter method should be adopted, as there is not much more difficulty with the one process than the other; but short descriptions of both methods will be given.

Total Solids.—To ascertain the total solids of a water, the operator must have a chemical balance, platinum capsule, water bath, and a measure graduated into cubic centimetres. If 70 cubic centimetres of the water are to be treated, then a pipette to hold that amount will be sufficient. Take care after it has been filled to remove external wet by a piece of blotting paper. The platinum dish must be carefully cleaned, dried, and weighed, and the quantity of water to be used then poured into it. The first part of the evaporation may be performed over a ring burner, taking care that there is no simmering. The latter part of the evaporation should be effected in a water bath, allowing the dish to remain in the bath for ten minutes after it appears to be quite dry. It is then removed, carefully wiped externally, allowed to cool down, and then weighed. The difference of the two weighings represents the total solids. If 70 c.c. have been used, then the number of milligrammes will be the number of grains per gallon. If 25 c.c. are used, as commonly is

the case, the result multiplied by 4 and then by ·7, or multiply at once by 2·8, the result is given in grains per gallon.

It is advisable to weigh twice, with an interval between the two, as deliquescent salts gain weight.

After the completion of the foregoing process the capsule may be heated to redness, cooled down, and weighed, the loss being called "volatile substances." If there is a large amount of organic matter in the water, the solids on incineration will blacken. The capsule, with its contained ash, should be kept, to be used for the determination of phosphates.

Chlorides. — For the determination of chlorides a burette graduated into cubic centimetres and tenths is needed, a solution of nitrate of silver 4·79 grammes to one litre of distilled water, a piece of chromate of potash, a beaker, and a stirring rod.

Into the beaker 70 c.c. of water are placed, and a small piece of chromate of potash. The silver solution is carefully dropped from the burette into the water, which is stirred all the time till the whole of the chlorine is precipitated, as indicated by the dark red chromate of silver becoming permanent. The number of cubic centimetres of silver solution used equals the number of grains of chlorine per gallon present in the water.

Phosphates.—The residue in the capsule after ignition is treated with a little nitric acid and evaporated to dryness. It is now again dissolved in a few drops of nitric acid, some distilled water added, and then filtered. If the filtrate is more than 5 c.c., it should be concentrated to a smaller bulk, and its own volume of molybdic solution added. It is then put to stand on a hot iron plate for fifteen minutes, when a colour or precipitate forms which is expressed as "traces," "heavy traces," or "very heavy traces" of phosphates.

The molybdic solution is prepared thus: one part of pure molybdic acid is dissolved in 4 parts of ammonia, Sp. Gr. 0·960. After filtration it is poured with constant stirring into 15 parts of nitric acid, Sp. Gr. 1·20.

Hardness.—For determining the hardness of water a burette divided into cubic centimetres and tenths is needed; a stoppered bottle and a standard soap solution are also needed.

The soap solution is prepared thus: ten grammes of green castile-soap are dissolved in a litre of a weak alcohol of about 35

per cent. One cubic centimetre of this solution precipitates one milligramme of carbonate of lime.

The burette is filled with the soap solution, and 70 c.c. of the water are put in the stoppered flask. The soap solution is cautiously run into the bottle, and the water is shaken after each addition. More solution is added, till a permanent lather forms on the surface of the water.

Each cubic centimetre of soap used equals one grain of carbonate of lime or its equivalents in a gallon of water. If the water is very hard, 35 c.c. of water should be used, and the measure filled up to 70 c.c. with distilled water. The quantity of soap solution must in this case be doubled to get the degrees of hardness per gallon. The hardness thus got is called the total hardness.

To get the permanent hardness, the 70 c.c. of water must first be boiled, and what is lost as steam made up by distilled water and then tested in the same way as above.

The temporary hardness is got by finding by subtraction the difference between the total and the permanent hardness.

Nitrates.—The presence of nitrates may be determined in several ways. Dr. Bond's modification of Horsley's test may be used, and is as follows:—Twenty minims of pure sulphuric acid are placed in a very small test tube, to which 10 minims of the water to be tested are added. One drop of pyrogallic acid (10 grains to 1 ounce of distilled water and 2 drops of sulphuric acid) is then dropped into the mixture. The depth of the amethyst or vinous brown colouration is a measure of the amount of nitrates present.

Estimation of Nitrates.—This can be effected by Lunge's nitrometer as follows: 250 c.c. of water are evaporated to 2 c.c. The nitrometer is charged with mercury, and the three-way stopcock closed, both to measuring tube and waste pipe. The concentrated filtrate is poured into the cup at the top of the measuring tube, and the vessel which contained it rinsed with 1 c.c. of water, and the contents added. The stopcock is opened to the measuring tube, and, by lowering the pressure tube, the liquid is sucked out of the cup into the tube. The basin is again rinsed with 5 c.c. of pure strong sulphuric acid, and this is also transferred to the cup and sucked into the measuring tube. The stopcock is once more closed, and 12 c.c.

more sulphuric acid put into the cup, and the stopcock opened to the measuring tube until 10 c.c. of acid have passed in. The excess of acid is discharged, and the cup and waste pipe rinsed out with water. Any gas which has collected in the measuring tube is expelled by opening the stopcock and raising the pressure tube, taking care no liquid escapes. The stopcock is closed, the measuring tube taken from its clamp and shaken by bringing it slowly to a nearly horizontal position, and then suddenly raising it to a vertical one. This shaking is continued until no more gas is given off, the operation, as a rule, being completed in fifteen minutes. A mixture of one part of water with five parts of sulphuric acid is prepared and allowed to stand to cool. After an hour, pour enough of this mixture into the pressure tube to equal the length of the column of acidulated water in the working tube, bring the two tubes side by side, raise or lower the pressure tube until the mercury is of the same level in both tubes, and read off volume of nitric oxide. This volume expressed in cubic centimetres, and corrected to normal pressure and temperature, gives, when multiplied by 0·175, the nitrogen in nitrates in grains per gallon, if 250 c.c. of water have been used.

Nitrites.—It is not often necessary to estimate the amount of nitrites present in water. Nitrites are best detected by a solution of meta-phenylenediamine, which gives a red colour in the presence of these. A half per cent. solution of the base in very dilute sulphuric acid is used. This test can be used to estimate the amount as well as to indicate the presence of nitrites.

Forschammer Process.

This process consists in estimating the oxidisable matter in water by the amount of oxygen absorbed. The following reagents are needed :—

Permanganate solution, made by dissolving ·395 grammes of pure potassium permanganate in 1 litre of distilled water; each c.c. contains ·0001 grammes of available oxygen.

Potassium Iodide solution, made by dissolving 1 part of pure potassium iodide in 10 parts of distilled water.

Dilute Sulphuric Acid, 1 part by volume of pure *sulphuric acid* in 3 parts by volume of pure distilled water.

Sodium Hyposulphite, 1 part of crystallized sodium hypo-

sulphite in 1,000 parts of water. This solution must always be standardised at the time of using, and corrected so that 1 c.c. shall be equal to 1 c.c. of the permanganate solution.

Starch water is also needed.

Two stoppered bottles of half a litre capacity are used, and into each 250 c.cs. of the water are introduced, and to each are added 10 cubic centimetres of dilute sulphuric acid and also 10 cubic centimetres of the standard permanganate solution. The bottles are then stoppered, and put into a hot-air oven, the temperature of which is kept at 27° C. for four hours.

At the end of fifteen minutes the bottle is removed from the hot-air oven, and a few drops of the potassium iodide solution are added to remove the pink colour; the standard hyposulphite is then added, until the yellow colour is nearly destroyed, after which a little starch solution is added, and the titration is continued till the water is colourless. The quantity of hyposulphite solution required to remove the blue colour in the water is noted; say, for example, 7 c.c. and 10 c.c. of permanganate were used, so $10-7=3$ c.c. $\times 4=12$ per litre, multiplied by $\cdot 0001 =$ $\cdot 0012$ grammes, or 1·2 milligrammes of 0 consumed in fifteen minutes. At the end of four hours the other 250 c.c. are treated in the same way.

Wanklyn, Chapman, and Smith Process.

This process consists of two stages,—

1*st.* Estimation of free or saline ammonia.

2*nd.* Estimation of albuminoid ammonia.

The principle of the process is the measurement of the nitrogenous organic matter in waters by the amounts of ammonia yielded.

Apparatus and Chemicals needed,—

1. Nessler reagent.
2. Dilute standard solution of ammonia.
3. Solution of potash and permanganate of potash.
4. Carbonate of soda.
5. Distilled water.
6. Retort.
7. Liebig's condenser.
8. Lamp and retort-holder.
9. Nessler glasses.

10. Half litre flask.
11. Measure for permanganate solution.
12. Graduated burette.
13. Pipette for Nessler solution.
14. Bottles.

Nessler's reagent. — Prepared by heating and stirring 35 grammes iodide of potassium, 13 grammes of eorrosive sublimate, in 800 e.e. of distilled water. A eold aqueous solution of eorrosive sublimate is added until the red eolour produeed is permanent. Then 160 grammes of solid eaustie potash are added to the mixture, which is then made up to 1 litre with distilled water.

Dilute Ammonia solution.—Two solutions are kept, a strong and a weak one. The strong eonsists of 3·15 grammes of chloride of ammonium in 1 litre distilled water. The weak one is made by diluting the strong with ninety-nine times its volume of distilled water, or in other words, 5 e.e. of former solution made up to 500 c.c. with distilled water. 1 e.e. = 0·01 milligramme of ammonia.

Potash and Permanganate of Potash solution.—Made by dissolving 200 grammes of solid potash and 8 grammes of erystallized permanganate of potash in a litre of water. The solution is boiled for awhile until $\frac{1}{4}$ has passed off as steam, and then made up to original volume with distilled water.

Carbonate of Soda. — Either a solution or freshly ignited earbonate of soda is used.

Distilled water must be perfeetly or nearly free from ammonia for making the various solutions. The eonnection between the retort and eondenser may be paeked by writing-paper. The glass eylinders or Nessler glasses should be quite eolourless, and have a file mark at 50 e.c. eapaeity. The greatest eare must be taken with all vessels used that they are elean and free from sourees of ammonia. Before using, the retort should be washed with strong hydroehlorie or sulphurie aeid, and then rinsed out with distilled water. The retort is then attaehed to the eondenser by means of a wide india-rubber tube, or paeked into the condenser by a little writing-paper, the Bunsen burner plaeed ready for lighting underneath, and the water turned on to the eondenser. Half a litre of the water is then put into the retort through a funnel kept for this and no other purpose, the

burner is then lighted, and a Nessler glass put at the end of the condenser. In a short time the condensed water will begin to drop into the Nessler glass, which has to be changed after 50 c.c. have been collected. Then 150 c.c. are allowed to distil over, but these are thrown away; the lamp is now withdrawn from the retort for a minute, and 50 c.c. of the permanganate solution are then introduced by a funnel used specially for this. The carbonate of soda may also be introduced at this time if it is required, the water being acid. The distillation is now continued, and three 50 c.c. of water that distil over are kept for Nesslerizing. It is usual to shake the retort after the permanganate has been introduced, to prevent bumping.

Nesslerizing. — This important process has to be applied to the first 50 c.c. which were distilled prior to the introduction of the permanganate solution, and to the three after its introduction. By the first the free ammonia is estimated, by the second the albuminoid ammonia.

The burette is filled with the standard solution of weak ammonia. Into the first distillate introduce by a small pipette 2 c.c. of Nessler's reagent, when a rich brown colour will be formed proportionate to the quantity of ammonia present. The next step is to match this tint, and thus estimate the ammonia in the distillate, and for this purpose a measured quantity of the weak ammonia solution is dropped into a clean Nessler glass, then the glass is filled up with distilled water to the 50 c.c. mark, 2 c.c. of Nessler's reagent added by the pipette for this purpose, and the whole is stirred up. The distillate with the contained Nessler, and the glass with the standard ammonia and Nessler added, are now placed side by side on a white surface, and carefully looked through. If the colours are identical, the Nesslerizing has been finished; if they are not, then another solution for comparison must be made up till the colours are identical, *and the amount of standard weak ammonia used for this purpose carefully noted.* For estimating the albuminoid ammonia the process is identical.

As only half a litre of water has been used, the results in each case are multiplied by 2.

In the case of the first or ammonia estimation, only one 50 c.c. is Nesslerized, as the first invariably contains $\frac{3}{4}$ of the whole ammonia; and to get the sum-total, $\frac{1}{3}$ is added.

The calculation is as follows: each c.c. of the weak standard ammonia solution used = ·01 milligramme of ammonia in the distillate.

50 c.c. used 9 c.c. standard	= ·09	milligramme
Add $\frac{1}{3}$, . . .	= ·03	„
	·12	„

Or for 1 litre = ·24 milligramme ammonia.

In the case of the albuminoid ammonia each separate distillate of the three is Nesslerized, and the total got by adding these, and multiplying by 2.

Tests for Metals.

The following tests will determine the presence of lead, iron, and copper:—

To some of the water in a porcelain dish add a drop of sulphide of ammonium. If there is any dark coloration, it will be due to one or more of the above metals. If it is iron, the addition of a few drops of hydrochloric acid will cause the colour to disappear; if lead or copper, the colour remains, and the water is unfit for use.

CHAPTER IX.

STABLES, BYRES, ETC.

Sect. XVI. subsect. (C). "*Any stable, byre, pig-sty, or other building in which any animal or animals are kept in such a manner as to be injurious to health.*"

Stables.

The manner in which a horse is kept concerns more than the owner, and the Public Health Act here indicates that a nuisance from this source will not be permitted. People are beginning to understand that there is hygiene for the lower animals as well as for man, and that neglect in the former case reacts on individuals other than the owners.

The construction of stables differs as widely as of dwellings, according to the value of the animals. At this time we can only describe a stable in so far as to exclude it from being considered a nuisance dangerous to health.

Ventilation of Stables.—For the health of horses this requires careful attention, especially in large stables. What should be the exact amount of air space has not been accurately determined, but a computation gives about 25 feet for every pound the horse weighs, or from 10,000 to 20,000 cubic feet of air per hour. This is practically keeping the animal in the open air. Practical experience in various armies has proved this to be safest, and such a disease as glanders has disappeared from cavalry horses by this treatment.

To ensure circulation of air, there must be an entrance and an exit. When the former exists, it will usually be found blocked by the groom, as he dislikes a cold stable, which makes the horses' coats stare, and causes him extra trouble to groom. The entrances for fresh air may either be windows or special air inlets, such as perforated bricks, just above the horses' heads. A good plan is to have a window on one side behind the horse, and a

perforated brick in front, while there should be some form of ridge ventilator. By these simple means a constant flow of air through the stable is ensured; but when the horse lies down, he gets below the current, and an air-brick near the ground-level is useful. The floor should be made of some impervious material, with an inclination towards a conduit, which discharges into a trapped gully. Such a floor can be made of concrete, roughened to prevent slipping. A good floor is made of Portland cement and roughly-ground stone, or granite chippings run upon a basis of brickbats. The walls of stables should be plastered, and either painted or whitewashed with hot lime.

The greatest nuisance, however, is usually found to arise from the imperfect or unfrequent removal of litter. When it is allowed to accumulate, an offensive ammoniacal odour prevails. The manner in which this litter is stored, until it is finally disposed of, must be attended to, and drainage should be provided in the place provided for its temporary storage; and the litter should not be compressed, but allowed to lie loosely and become freely aerated. Frequent removal of such collections is the only proper treatment of such nuisances.

The dangers which arise from stables occur when they are improperly kept and dwelling-houses are near. Very often a dwelling-house is above a stable, and this can never be healthy. A visit to "mews" in any city shows all the objections to such arrangements.

Byres.

That byres should be kept in a high state of cleanliness—at least where cows are kept—is more fully understood than when this Act was passed; and in 1885 an Order, called the Dairies, Cowsheds, and Milk Shops Order, was passed, conferring considerable powers on Local Authorities to deal with these. As this is a most important Order, it is given *in extenso* at the end of this section. This Order is a valuable addition to the power which Local Authorities have to deal with byres, but it leaves a good deal undone.

At the present time we are dealing, however, with byres so kept as to be dangerous to health, and we will now describe the proper construction of a byre. In the first place, no byre, however cleanly kept, should ever be in close proximity to a dwelling-

house. The walls should be made of stone or brick, plastered inside, and provided with properly fitting doors and windows, the latter admitting of opening. The roof should be of wood, covered with asphalte, slates, or tiles. Rhones and rain-conductors should be provided. There should be sufficient cubic space inside to give each cow 1,000 cubic feet.

The floor should be made of impermeable material, as cement, concrete, or asphalte, with an inclination to a channel behind the cows, which also should have a free inclination to a grating with a trapped gully. This should be scavenged with a broom, and flushed with water, at least twice a day. The feeding-troughs should be made of iron or glazed fireclay, and be kept clean.

Litter should be carefully removed certainly twice a day, and there never should be any accumulation of manure in the byre. Neither should it be allowed to accumulate outside for any length of time. Care should be taken, where it is temporarily collected, that this place is made water-tight, so that no soakage can take place into the soil, and perhaps into a water supply. Ballard recommends a covered iron receptacle to carry away manure, and not to store it at all.

The ventilation should be by ridge ventilators and by the doors and windows, which open. Unfortunately, free ventilation means less milk from the cows, and cow-owners try to dispense with ventilators.

The walls and ceiling, if there is one, if not, then the roof, should be limewashed twice a year at least. Ballard recommends a dado of cement or zinc 4 feet high, to run round the walls, and to be cleaned with water at short intervals.

The Dairies, Cowsheds, and Milk Shops Order of 1885.

At the Council Chamber, Whitehall,
the 15th day of June 1885.

By Her Majesty's Most Honourable Privy Council.
Present: Lord President, Mr. Trevelyan.

The Lords and others of Her Majesty's Most Honourable Privy Council, by virtue and in exercise of the powers in them vested under the Contagious Diseases (Animals) Act, 1878, and of every other power enabling them in this behalf, do order, and it is hereby ordered, as follows:—

Short Title.—1. This Order may be cited as the Dairies, Cowsheds, and Milk Shops Order of 1885.

Extent.—2. This Order extends to England and Wales and Scotland only.

Commencement.—3. This Order shall commence and take effect from and immediately after the thirtieth day of June one thousand eight hundred and eighty-five.

Interpretation.—4. In this Order—

The Act of 1878 means the Contagious Diseases (Animals) Act, 1878.

Other terms have the same meaning as in the Act of 1878.

Revocation of former Orders. — 5. The Dairies, Cowsheds, and Milk Shops Order of July 1879 is hereby revoked: Provided that nothing in this Order shall be deemed to revive any Order of Council thereby revoked, or to invalidate or make unlawful anything done before the commencement of this Order, or interfere with the institution or prosecution of any proceeding in respect of any offence committed against, or any penalty incurred under, the the said Order hereby revoked.

Registration of Dairymen and others.—6.—(1.) It shall not be lawful for any person to carry on in the district of any Local Authority the trade of cow-keeper, dairyman, or purveyor of milk unless he is registered as such therein in accordance with this Article.

(2.) Every Local Authority shall keep a register of persons from time to time carrying on in their district the trade of cow-keepers, dairymen, or purveyors of milk, and shall from time to time revise and correct the register.

(3.) The Local Authority shall register every such person, but the fact of such registration shall not be deemed to authorize such person to occupy as a dairy or cowshed any particular building or in any way preclude any proceedings being taken against such person for non-compliance with or infringement of any of the provisions of this Order or any Regulation made thereunder.

(4.) The Local Authority shall from time to time give public notice by advertisement in a newspaper circulating in their district, and, if they think fit, by placards, handbills, or otherwise, of registration being required, and of the mode of registration.

(5.) A person who carries on the trade of cow-keeper or dairyman for the purpose only of making and selling butter or cheese or both, and who does not carry on the trade of purveyor of milk, shall not, for the purposes of registration, be deemed to be a person carrying on the trade of cow-keeper or dairyman, and need not be registered.

(6.) A person who sells milk of his own cows in small quantities to his workmen or neighbours, for their accommodation, shall not,

for the purposes of registration, be deemed, by reason only of such selling, to be a person carrying on the trade of cow-keeper, dairyman, or purveyor of milk, and need not, by reason thereof, be registered.

Construction and Water Supply of new Dairies and Cowsheds.—7.—(1.) It shall not be lawful for any person following the trade of cow-keeper or dairyman to begin to occupy as a dairy or cowshed any building not so occupied at the commencement of this Order, unless and until he first makes provision, to the reasonable satisfaction of the Local Authority, for the lighting, and the ventilation, including air space, and the cleansing, drainage, and water supply of the same, while occupied as a dairy or cowshed.

(2.) It shall not be lawful for any such person to begin so to occupy any such building without first giving one month's notice in writing to the Local Authority of his intention so to do.

Sanitary State of all Dairies and Cowsheds.—8. It shall not be lawful for any person following the trade of cow-keeper or dairyman to occupy as a dairy or cowshed any building, whether so occupied at the commencement of this Order or not, if and as long as the lighting, and the ventilation, including air space, and the cleansing, drainage, and water supply thereof are not such as are necessary or proper—

(*a*) for the health and good condition of the cattle therein; and

(*b*) for the cleanliness of milk-vessels used therein for containing milk for sale; and

(*c*) for the protection of the milk therein against infection or contamination.

Contamination of Milk.—9. It shall not be lawful for any person following the trade of cow-keeper or dairyman or purveyor of milk, or being the occupier of a milk store or milk shop—

(*a*) to allow any person suffering from a dangerous infectious disorder, or having recently been in contact with a person so suffering, to milk cows or to handle vessels used for containing milk for sale, or in any way to take part or assist in the conduct of the trade or business of the cow-keeper or dairyman, purveyor of milk, or occupier of a milk store or milk shop, so far as regards the production, distribution, or storage of milk; or

(*b*) if himself so suffering or having recently been in contact as aforesaid, to milk cows, or handle vessels used for containing milk for sale, or in any way to take part in the conduct of his trade or business, as far as regards the production, distribution, or storage of milk—

until in each case all danger therefrom of the communication of infection to the milk or of its contamination has ceased.

10. It shall not be lawful for any person following the trade of

cow-keeper or dairyman or purveyor of milk, or being the occupier of a milk store or milk shop, after the receipt of notice of not less than one month from the Local Authority calling attention to the provisions of this Article, to permit any water-closet, earth-closet, privy, cesspool, or urinal to be within, communicate directly with, or ventilate into, any dairy or other room used as a milk store or milk shop.

11. It shall not be lawful for any person following the trade of cow-keeper or dairyman or purveyor of milk, or being the occupier of a milk store or milk shop, to use a milk store or milk shop in his occupation, or permit the same to be used, as a sleeping apartment, or for any purpose incompatible with the proper preservation of the cleanliness of the milk store or milk shop, and of the milk-vessels and milk therein, or in any manner likely to cause contamination of the milk therein.

12. It shall not be lawful for any person following the trade of cow-keeper or dairyman or purveyor of milk to keep any swine in any cowshed or other building used by him for keeping cows, or in any milk store or other place used by him for keeping milk for sale.

Regulations of Local Authority.—13. A Local Authority may from time to time make regulations for the following purposes, or any of them:—

(*a*) For the inspection of cattle in dairies.

(*b*) For prescribing and regulating the lighting, ventilation, cleansing, drainage, and water supply of dairies and cowsheds in the occupation of persons following the trade of cow-keepers or dairymen.

(*c*) For securing the cleanliness of milk-stores, milk shops, and of milk-vessels used for containing milk for sale by such persons.

(*d*) For prescribing precautions to be taken by purveyors of milk and persons selling milk by retail against infection or contamination.

Provisions as to Regulations of Local Authority.—14. The following provisions shall apply to Regulations made by a Local Authority under this Order:—

(1) Every Regulation shall be published by advertisement in a newspaper circulating in the district of the Local Authority.

(2.) The Local Authority shall send to the Privy Council a copy of every Regulation made by them not less than one month before the date named in such Regulation for the same to come into force.

(3.) If at any time the Privy Council are satisfied on inquiry, with respect to any Regulation, that the same is of too restrictive a character, or otherwise objectionable, and

direct the revocation thereof, the same shall not come into operation, or shall thereupon cease to operate, as the case may be.

Existence of Disease among Cattle.—15. If at any time disease exists among the cattle in a dairy or cowshed, or other building or place, the milk of a diseased cow therein—

(*a*) shall not be mixed with other milk; and

(*b*) shall not be sold or used for human food; and

(*c*) shall not be sold or used for food of swine, or other animals, unless and until it has been boiled.

Acts of Local Authorities.—16.—(1.) All Orders and Regulations made by a Local Authority under the Dairies, Cowsheds, and Milk Shops Order of July 1879, or any Order revoked thereby, and in force at the making of this Order, shall, as far as the same are not varied by or inconsistent with this Order, remain in force until altered or revoked by the Local Authority.

(2.) Forms of Registers and other forms which have been before the making of this Order prepared for use by a Local Authority under the Dairies, Cowsheds, and Milk Shops Order of July 1879, or any Order revoked thereby, may be used, as far as they are suitable, for the purposes of this Order.

Scotland.—17. Nothing in this Order shall be deemed to interfere with the operation of The Cattle Sheds in Burghs (Scotland) Act, 1866.

The Regulation of Dairies, Cowsheds, and Milk Shops.

BOARD OF SUPERVISION,
EDINBURGH, 16*th August* 1886.

SIR,—I am directed by the Board of Supervision to point out to you that an Act was passed in the last Session of Parliament (Contagious Diseases (Animals) Act, 1886), which transfers the powers vested in the Privy Council and Local Authorities acting under the Contagious Diseases (Animals) Act (1878), relating to dairies, cowsheds, and milk shops, to the Board of Supervision and Local Authorities acting under the Public Health Act (1867).

Section 34 of the Contagious Diseases (Animals) Act of 1878 is as follows:—

"34. The Privy Council may from time to time make such general or special orders as they think fit, subject and according to the provisions of this Act, for the following purposes or any of them:—

"(i.) For the registration with the Local Authority of all persons carrying on the trade of cow-keepers, dairymen, or purveyors of milk.

"(ii.) For the inspection of cattle in dairies, and for prescribing

and regulating the lighting, ventilation, cleansing, drainage, and water supply of dairies and eowsheds in the oecupation of persons following the trade of cow-keepers or dairymen.

"(iii.) For seeuring the cleanliness of milk stores, milk shops, and of milk-vessels used for containing milk for sale by such persons.

"(iv.) For preseribing cautions to be taken for protecting milk against infeetion or contamination.

"(v.) For authorizing a Loeal Authority to make regulations for the purposes aforesaid, or any of them, subject to sueh eonditions, if any, as the Privy Couneil preseribe."

The provisions of the Aet of last Session whieh affect Seotland are eontained in seetion 9:—

"9.—(1.) The powers vested in the Privy Council of making general or special Orders under seetion thirty-four of the principal Aet, for the purposes in that seetion mentioned, are hereby transferred to and shall heneeforth be exercisable by the Local Government Board; every sueh Order shall have effeet as if enaeted in this seetion, and shall be published in sueh manner as the Local Government Board may direet; and the said Board may from time to time alter or revoke any such Order.

"(3.) Any expenses ineurred by a Loeal Authority in the metropolis in pursuanee of seetion thirty-four of the prineipal Aet, as amended by this section, shall be defrayed out of the loeal rate applicable to their expenses under the principal Act; and any expenses so incurred by any other Loeal Authority shall be defrayed as if they were incurred in the execution of the Public Health Aet, 1875, and in the case of a rural sanitary authority shall be deemed to be general expenses.

"(4.) The Loeal Authority and their offieers, for the purpose of enforeing the said Orders and any Regulations made thereunder, shall have the same right to be admitted to any premises as the Loeal Authority, within the meaning of the Public Health Act, 1875, and their offieers have, under section one hundred and two of that Aet, for the purpose of examining as to the existenee of any nuisanee thereon; and if such admission is refused the like proceedings may be taken, with the like ineidents and consequenees as to orders for admission, penalties, costs, expenses, and otherwise, as in the case of a refusal to admit to premises for any of the purposes of the said section one hundred and two, and as if the Loeal Authority mentioned in the said Act ineluded a Local Authority in the metropolis as defined in this seetion.

"Provided that nothing in this section shall authorize any person, except with the permission of the Local Authority under

the principal Act, to enter any cowshed or other place in which an animal affected with any disease is kept, and which is situate in a place declared to be infected with such disease.

"(5). The like penalties for offences against Orders or Regulations made for the purposes of section thirty-four of the principal Act as amended by this section may be imposed by the Local Government Board or Local Authority making the same, and such offences may be prosecuted and penalties recovered in a summary manner, and subject to the like provisions, as if such Orders or Regulations were bye-laws of a Local Authority under the Public Health Act, 1875, and as if the Local Authority mentioned in that Act, included a Local Authority in the metropolis as defined in this section.

"(6.) Whereas under the powers of the principal Act the Privy Council have made an Order known as the Dairies, Cowsheds, and Milk Shops Order of 1885, and certain authorities have made regulations under that Order, or having effect in pursuance thereof; and it is expedient by reason of the foregoing provisions of this section to make provision respecting such Order and Regulations: Be it therefore enacted as follows:—

"(*a*) The Dairies, Cowsheds, and Milk Shops Order of 1885, and any regulations thereunder, or having effect in pursuance thereof, made by any Local Authority under the principal Act, other than the Local Authority of a county, shall be deemed to have been made respectively by the Local Government Board and by a Local Authority under this section; and any such regulations made by the Local Authority of a county, within the meaning of the principal Act, shall, so far as they extend to the district of any Local Authority as defined in this section, be deemed to have been made by such Local Authority.

"(*b*) So much of any register kept by the Local Authority of any county under the said Order as relates to the district of any Local Authority as defined in this section, or a copy thereof, shall, as soon as may be after the passing of this Act, be delivered to the Local Authority by the Local Authority of the county.

"(7.) In the application of this section to Scotland, the expression 'Local Government Board' shall mean the Board of Supervision for relief of the Poor and for Public Health; the expression 'Local Authority' shall mean the Local Authority under the Public Health (Scotland) Act, 1867; the expressions 'Public Health Act, 1875,' and 'section one hundred and two of the said Act,' shall mean respectively the Public Health (Scotland) Act, 1867 (30 and 31 Vict. c. 101), and section seventeen of the said Act; the expression 'Bye-laws of a Local Authority' shall mean rules and

regulations made by a Local Authority under the Public Health (Scotland) Act, 1867; and generally the Board of Supervision and the Local Authority under the Public Health (Scotland) Act, 1867, shall have all the powers of the Privy Council, and the Local Authority under section 34 of the Contagious Diseases (Animals) Act, 1878, with regard to the regulation of dairies, cowsheds, and milk shops: Provided always, that no general or special order made by the Board of Supervision under this section shall be binding until it has been confirmed by the Secretary for Scotland, subject to such conditions, if any, as the Secretary for Scotland shall think fit."

The main provisions of this section to which the Board desire to direct the attention of the Local Authority, are these:—

1. The powers exercised by the Privy Council, under the 34th section of the Contagious Diseases (Animals) Act of 1878, as regards dairies, cowsheds, and milk shops, are transferred to the Board of Supervision.

2. The powers exercised by the Local Authority under the Contagious Diseases (Animals) Act of 1878, [in so far as regards the regulation of dairies, cowsheds, and milk shops, in terms of section 34 of that Act], are transferred to the Local Authority under the Public Health Act.

3. Expenses incurred by the Local Authority in carrying out the provisions of the Act, are to be held as expenses incurred under the Public Health Act.

4. The Local Authority and their officers have the same right to be admitted to any premises for the purposes of the Act, as they and their officers have, under the Public Health Act, for the purpose of examining as to the existence of nuisances. [But the Act does not authorize any person except with the consent of the Local Authority under the Animals Act, to enter any cowshed or other place in which an animal affected with any disease is kept, and which is situated in a place declared to be infected with such disease.]

5. Penalties may be recovered and prosecutions conducted in the same manner as under the Public Health Act.

6. Any Orders issued by the Privy Council, or regulations duly made by a Local Authority, as regards dairies, cowsheds, and milk shops, prior to the passing of the Act of 1886, are continued in force, and are to be deemed to have been made respectively by the Board of Supervision and the Local Authority.

7. The register or a copy of the register, kept by the Local Authority under the Contagious Diseases (Animals) Act, in so far as it applies to the district of each Local Authority under the Public Health Act, is to be delivered to the Local Authority under

the Public Health Act, by the Local Authority under the Contagious Diseases (Animals) Act, as soon as may be after the passing of the Act.

[Copies of any regulations made by the Local Authority under the Contagious Diseases (Animals) Act ought to be transmitted at the same time.]

The Privy Council having issued, under the powers vested in them by section 34 of the Act of 1878, an Order dated 15th June 1885, a copy of the Order was sent to you on 19th June 1885, by direction of the Board of Supervision, for the information of the Local Authority. That Order (of which a copy is herewith enclosed) is still in force, and will continue to be so until varied or revoked by the Board of Supervision.

Any regulations duly made by the Local Authority under the Contagious Diseases (Animals) Act in respect of that Order, are still in force, and will continue to be so until varied or revoked.

Any regulations made by a Local Authority, in regard to which the Privy Council have intimated that the same are of too restrictive a nature, or otherwise objectionable, must be submitted of new to the Board of Supervision.

It is obvious that co-operation between the officers of the Local Authority under the Public Health Act, and of the officers under the Animals Act of 1878, is extremely desirable. The Privy Council have requested the Local Authority under the Animals Act to instruct their inspector to give notice to the sanitary inspector of any case of human infectious disease within his district, in dairies, cowsheds, or milk shops, whereby milk might be contaminated. The Board are of opinion, on the other hand, that any case of disease in animals found by the sanitary inspector in dairies or cowsheds, should be reported by him to the inspector under the Animals Act; and it shall be the duty of the sanitary inspector without delay to make such report.

It is now an ascertained fact that disease is largely disseminated from dairies and milk shops where the sanitary arrangements are defective, and from which persons suffering from infectious disease have not been removed. There is no doubt, therefore, that the statute imposes on the Local Authority a most important duty, which the Board trust will be duly discharged.

You will submit this communication to the Local Authority at an early date, and transmit to me, for the information of the Board, a copy of the Local Authority's minute thereon, together with a statement of the steps resolved on or taken, in order to carry into effect the provisions of the statute.—I am, etc.,

John Skelton, *Secretary.*

To the Clerk or Sanitary Inspector of the Local Authority under the Public Health Act.

Pig-styes.

The keeping of pigs, in country places at least, leads to unmitigated nuisances, not the least being pollution of water supplies by soakage. It is thus a pity that a Local Authority cannot enact that no pig-stye should be erected within, say, 50 yards of any dwelling-house. A decision by the Court of Session in 1860 ruled that it was *ultra vires* of a Local Authority to enact that no pig should be kept within 10 yards of a dwelling-house. And this short distance is quite absurd. It should further be kept in view that a water supply may be polluted by such a cause a long distance away.

The following conditions should be observed in the construction of pig-styes :—

A pig-stye should be as far removed as possible from dwelling-houses, and certainly should not abut on a dwelling-house. The floor of the stye should be made of matter impervious to water, such as concrete, cement, or asphalte, and with a hang to secure drainage into some channel, such as glazed fireclay blocks, leading into an underground drain. Sub-irrigation of a cottage garden in this manner would be very useful. It is desirable that the walls of the stye should be built of stone or bricks, and not made of wood. The pig should be supplied with an abundance of dry litter, which should be removed frequently. Washing of the pig is desirable, both in the owner's interest and in the interest of those living near. Offal from slaughter-houses should not be given to pigs.

Such simple rules as the above do not inflict much hardship on keepers of pigs, and if they were carried out, very grave nuisances would be prevented.

Powers and Duties of Local Authorities under Subsect. (C).

As these do not differ from those of the two former subsections, it is unnecessary to repeat what has already been stated.

Subsect. (D). " *Any accumulation or deposit of manure or other offensive matter within fifty yards of any dwelling-house within the limits of any burgh, or wherever situated, if injurious to health, or any accumulation of police manure within a quarter*

of a mile of the municipal boundaries of any burgh (excepting the city of Glasgow), or any accumulation of deposits from ashpits, or manure from town or village, laid nearer than fifty yards to a public or parish road, or dwelling-house."

There is, perhaps, no clause in the whole Act more important than this one, dealing as it does with a class of nuisances which everywhere abounds in country villages; but, except in the case of burghs, deposits of manure are tolerated by the Act, unless they can be proved to be dangerous to health, or unless they are of the class included in the end of the clause. The distance beyond which such nuisances may be allowed to accumulate is far too short, as smells may be wafted by winds a very long way, and soakage of course from such accumulations may be carried an undefined distance, leading to pollution both of ground-air and subsoil water. The word "burgh" should have been omitted, and accumulations of any offensive matters should be entirely prohibited from the neighbourhood of dwelling-houses.

Wherever people are congregated together, or even wherever one individual is found, a certain amount of refuse matter necessarily results, and one of the great sanitary questions is, How can this refuse matter be disposed of without danger, and economically? This refuse is matter of variable composition, such as cinders, ashes, broken glass, crockery, old boots, animal and vegetable refuse, mixed up with the waste materials of the trade peculiar to the individual or the community.

The questions to consider are, How is this matter to be stored, and for what length of time? How is it to be removed from the town or village, and how finally utilised or got rid of? These questions will now be discussed under their different headings.

Question of Collection and Storage.—In large cities with a thoroughly organised sanitary department, and with a large staff of scavengers, the collection and removal of refuse matter, although always difficult, are usually well done. In villages and small towns, where there is probably no sanitary department at all, where there may be a sanitary inspector who knows his work or does not, and where at least for an ordinary-sized village there may be one scavenger, the collection, storage, and removal

of refuse matters form most serious problems, which are too often left unsolved, and filth abounds in every direction. In the survey of a village we usually find that there may be some form of ashpit, improperly constructed, and used also as a privy, into which all sorts of refuse matters are thrown, from whence they are removed when the place can contain no more. Or there may be no pretensions at receptacles for storage, and refuse is deposited anywhere and everywhere. I do not overstate the mark when I state that this is the commonest method employed in Scotland.

Instead of this system, or rather want of system, if ashpits were properly constructed as already described, water-tight and small, and were cleared out every other day, no great evil would result; but a much better plan is to collect the various refuse matters in iron boxes, fitted with covers, or even creosoted wooden tubs, also with covers. These should be placed at some convenient place for a house or block of houses, and removed as often as possible, in towns certainly every day, in villages say every four days. In towns where everything must be done to prevent a nuisance, the contents of these receptacles should be removed in covered dust-carts, as is done in Edinburgh. The next question is as to the disposal of the contents of the receptacles, and I shall briefly describe how this may be accomplished in a small town or village, and in a large city. The following description is taken from a paper by Dr. Slade King, medical officer of health, on the disposal of the refuse matter of a town of 8000 inhabitants, and shows that such matters can be got rid of without causing nuisance, and with little expense. A field was secured, and a trench 15 feet deep, 25 feet wide, and 65 feet long, was made in it, leading at either end by a gentle gradient to surface level. Along one side a shelter was made, consisting of a galvanised iron roof on posts; under this the carts were tipped. The dust sorter separates with an iron rake, stones, clinkers, and other material for road-making. Bones, rags, etc., are kept as his own perquisite; while vegetable and animal refuse, paper, small coal, and combustible matter he distributes along the sloping side of the trench, and sets fire to, gradually covering them up with ashes and other refuse. Such a heap burns for six weeks without the necessity for relighting, and gives off scarcely any appreciable odour. The ashes are purchased by builders at 1s. 3d. per ton.

Instead of a trench, a small kiln could be made at a cost of from £25 to £30. The total cost for a town of 8000 inhabitants, for twelve months, including horses, carts, etc., was £237, 9s. The sale of ashes realised £45, 10s. Thus by a cheap form of "destructor" such matters can be got rid of with little trouble and expense, even in small towns.

In large cities, where expense is not so serious a consideration, the principle adopted is much the same, although the details are more elaborate. Several forms of apparatus are used, such as Fryer's Destructor, Firman's Dryer and Carbonizer. Ashes, etc., collected in ash tubs (or otherwise), are first secured and separated into two portions—fine ash and coarser substances. The fine ash is mixed with such of the contents of the pails as will make a manure. The coarse materials are discharged into a "Destructor," the "clinkers" are passed into a mortar mill, and ground for cement. Street sweepings are burned in an apparatus called a carbonizer, and converted into charcoal. Pail contents which have been mixed with fine ashes or charcoal are conveyed to an air-tight store-tank. A small quantity of acid is used to fix the ammonia. The liquid contents are drawn off into two evaporators, after being partially dried; they are then finally dried by Firman's Dryer, being converted into a dry powder resembling guano in appearance and quality, and which sells for about £6, 10s. per ton.

The various processes are carried on without causing any nuisance, and the one process is so arranged as to assist the other. No coal is bought, as enough can be got from the refuse, while the steam and vapour escaping from the evaporator are used to furnish heat for the main concentrating apparatus. Systems such as the above are now in operation in many large towns.

In those two examples it is seen that a small town and a large city each has means at its command for the safe and satisfactory disposal of the various refuse matters which accumulate wherever people congregate together. Street sweepings and the contents of ashpits generally find purchasers, and do not require to be destroyed by fire; but a large and dangerous portion of the refuse of villages and towns cannot be got rid of in any more satisfactory manner than by cremation.

Importance of satisfactorily disposing of Refuse Matters.

Sir John Simon, in his work so frequently referred to, speaks of two gigantic evils to be encountered in England, one of which is—

"First, the omission (whether through neglect or through want of skill) to make due removal of refuse matters, solid and liquid, from inhabited places;" and farther on he refers to "uncleanliness" as being one of the deadliest of our present removable causes of disease. Impurities which are included in the clause we have been dealing with, are nuisances in the ordinary sense of the word apart from its public health meaning, in so far as they interfere with our rights, powers, and privileges, being offensive to sight and smell. But they have a much more important influence, not only from their proneness to decomposition under the action of heat, moisture, and those minute organisms associated with putrefaction, with the subsequent evolution of mephitic gases, but from the fact that such collections of animal and vegetable refuse are the breeding grounds of the micro-organisms associated with many diseases, such as diarrhœa, cholera, diphtheria, and typhoid fever; and even pneumonia is sometimes caused by filth matters. These are selected as special examples, not as by any means exhausting the list, and generally it may be stated that the emanations from filth aggravate every disease which may attack the human body. The remedy for such preventable diseases is to remove refuse matters whenever they are found,—not to store them near dwelling-houses; and, further, to utilize or destroy them, so that they can at no time endanger the public health.

Powers and Duties of Local Authorities under Subsect. (D).

The various penalties for contravention of any decree or interdict under this subsection are the same as for those already fully described. In the case of manure, etc., removed by the Local Authority, if the value is under two pounds, or if delay would be dangerous to health, the sheriff, justice, or magistrate may order the *immediate* removal, sale, or destruction of such. If above the value of two pounds, or delay not prejudicial to health, the articles may be sold by public roup after five days'

notice by handbills posted in the locality. The proceeds of the sale to be applied to defraying expenses incurred, any surplus being handed over to the owner of the thing sold. If the proceeds of the sale are not sufficient to pay expenses, the author of the nuisance or owner of the premises must pay balance.

By section LI., where notice has been given by Local Authority or officers for the periodical removal of manure or other refuse matter from mews, stables, or other premises (whether such notice shall be by public announcement in the locality or otherwise), and subsequently to this the person or persons shall not remove the same, or shall permit a further accumulation, and shall not continue such periodical removal as the Local Authority or officers may direct, they shall be liable without further notice to a penalty not exceeding twenty shillings for every day during which manure or refuse is allowed to accumulate.

CHAPTER X.

WORKS—TRADES.

SUBSECT. (E). "*Any work, manufactory, trade, or business injurious to the health of the neighbourhood, or so conducted as to be offensive or injurious to health, or any collection of bones or rags injurious to health.*"

This subsection is most comprehensive, including apparently every trade or business so conducted as to be offensive or injurious to health. In 1882 a report was prepared by Dr. Ballard for the Local Government Board of England, dealing with the whole question of effluvium nuisances in connection with various trades and industries; and this report, forming a book of about 200 pages, shows the extent of the subject. It is quite impossible to deal with this important subsection otherwise than generally, and the most satisfactory arrangement will be to follow in order certain specified trades and businesses given in section XXX. of the Act, and which Local Authorities have special powers to deal with. The plan we will follow in this section will be to indicate how such trades or businesses may be conducted so as to reduce to a minimum their offensive or injurious properties, then to describe in what way they act as nuisances; and lastly, to point out what are the powers and duties of Local Authorities in connection with such trades or businesses.

Business of Blood Boiler.—This business, according to Ballard, is nearly obsolete. It is conducted either by throwing steam into the blood, or boiling it in a pan with a fire beneath. When fresh blood is used, the process is not so offensive; but when old, most offensive odours are given off. The steam and vapours given off from the pan in which the blood is boiled should be collected by a hood leading into a flue in connection with a fan, which directs them into a spray condenser, and then

into a condenser of running water. Vapours not condensible should pass through a fire. Blood should be stored in tight vessels till used. Blood is prepared for Turkey-red dyers, and may thus give rise to offensive smells; but these may be removed by drawing the vapours out of the place where the business is conducted by means of a fan, passing them through the fire of a furnace, and discharging by a high chimney.

Making of blood albumen often causes serious nuisances. The blood clot should be kept in tight vessels till used. The yards should be paved, and washed daily. The separation room and room in which clots are sliced, if near dwelling-houses, should be enclosed on all sides, ventilated at the roof, and well paved. The floors and all vessels used should be carefully cleaned; the walls periodically lime-washed.

In making manure of blood, the vapours from the acid used should be made to pass through a fire.

Bone-Boiling.—This may be done by steam, or in a pan with a fire beneath. The principal nuisance arises from the storage of bones in process of decomposition. To diminish the effluvia, they should be kept in tarred casks, or when in heap, covered over by a tarpaulin. The steam from the boilers should be conducted either into condensers or tall chimneys, and other vapours passed into the fire.

The bone-hole, or place where boiled bones are stored, should have a pipe leading from it into the furnace chimney, or the place dried by coke fires inside. Bones are utilised for the manufacture of animal charcoal, and in the process the following are included:—

Boiling of the bones, distillation of the bones, condensation and utilisation of liquors, collection and utilization of the gas produced, manufacture of artificial manure. In these various processes, serious nuisances often arise; but reference must be made to Dr. Ballard's report for full information.

Tanning. — The process by which hides are converted into leather is an elaborate one, and cannot be described here. Nuisance is caused by smells from the hides, and Ballard recommends for this the application of some antiseptic. Soaking of the hides is a highly objectionable process, and should be done away from human habitations.

For the general offensive condition of a tan-yard, Ballard

recommends proper drainage, paving, and general cleanliness, and the speedy removal of all offensive matters.

Slaughtering of Cattle. — In the preceding pages we have briefly discussed certain trades which, if improperly conducted, become most serious nuisances from effluvia, and thus cause danger to health. In the case of slaughter-houses this danger is also great, with this addition, that there is the direct possibility of human food becoming polluted. Further, with the knowledge that many diseases of bovine origin may be transmitted to man, it behoves that slaughter-houses should not only be properly constructed, but strictly supervised. Most sanitary authorities hold that for proper supervision, and to insure that proper premises alone should be used as slaughter-houses, every village and town should have a common slaughter-house; but the Act gives no power to Local Authorities to insist on this, and they should therefore exert what power they have to secure the very best possible arrangements.

A slaughter-house should be removed as far as possible from the neighbourhood of inhabited houses, and certainly no slaughter-house should abut on any dwelling-house, or a dwelling-house be permitted to be above a slaughter-house.

The walls should be made of stone or brickwork with a proper water-tight roof, provided with louvred ridge ventilators. The windows should be made to open for purposes of ventilation, or a part may be louvred, and there also should be a louvred opening in the door. To insure a cross current of air circulating through the place, air should be admitted at opposite sides by air-bricks or other openings in the walls.

The inside of the walls should be rendered impervious to moisture for at least 5 feet above the floor, and this may be done by cementing or lining with zinc-sheeting. The floor should be rendered impervious by flags set in cement resting on a concrete foundation. A good floor is described by Ballard, consisting of Portland cement mixed with roughly-ground stone or granite, laid on a basis of small brickbats, the whole thickness being about $3\frac{1}{2}$ to 4 inches. The surface of the floor should be roughened to prevent slipping, and should be sloped, so that liquid matters may run to a channel leading to a trapped gully outside the house. Any woodwork in the interior should be whitewashed at least twice a year, or oil painted, and frequently washed.

There should be a water supply under sufficient pressure for cleansing the floor and utensils used in the premises.

To keep the floor dry, as much blood as possible should be collected in iron pails during the slaughtering of animals, and no offal, hides, skins, or manure should be retained in the slaughter-house, but put in some covered iron box, and removed as quickly as possible. The floor and impervious parts of the wall, and all utensils, should be washed after each slaughtering.

No dog or other animal should be kept in the slaughter-house. A special byre or lair should be provided for keeping animals before slaughtering, and this should be distinct and removed from the slaughter-house.

Slaughtering of other Animals.—The establishments where horses are slaughtered are called "knackeries," and require nearly as much care as ordinary slaughter-houses, to prevent them from becoming nuisances. Dead horses are often brought to these places, and unless at once utilised create nuisances from their decomposition. The premises should be isolated from inhabited houses, and constructed, as regards floors, walls, ventilation, etc., as ordinary slaughter-houses; and the same care should be taken for the careful removal of blood, offal, and manure. Where fat-melting and blood-boiling are carried on, care must be taken to condense the steam and vapours, and to burn that which is not condensible.

Soap-Boiling.—Soap is made by the addition of caustic alkali to animal or vegetable fats or oils. Nuisance may arise from the rendering of the fat used, melting of fats and tallows, bleaching of palm oil, and vapours from boiling pans, when certain kinds of fat are used, as "ships' fat." To obviate these various nuisances, the following precautions are necessary. In rendering the fat, the boiler should have an iron cover with a flue leading into the furnace, where combustible vapours are destroyed. Where steam rendering is adopted, the vapours should be discharged by a high shaft, or they may be got rid of by condensers, or burning. The same procedure may be applied to the melting out of tallow by steam, and to the refining of palm oil. In the actual process of soap-boiling, the pans should have a cover over half their extent, with a pipe leading to the boiler fire, where it discharges into the ashpit.

Business of Skinner.—The first part of this business is to

cleanse the skins, and to lime them; then they are hung up to dry, after this the wool is taken off, the skin is thrown into milk of lime, then stored till removal. This is the treatment of English skins, but foreign skins are dealt with differently; they are first softened in water, then "furrs" are removed, the damp skins are hung up in a hot chamber, and the wool detached. This trade is very liable to cause most offensive nuisances, from decomposition of the skins, and from the liming and washing of them. The skins should be stored and also limed in covered buildings, and the water used for soaking should be frequently changed. The waste lime should be removed in covered carts; and yards where operations are carried on should be paved, drained, and kept clean. The walls of the various houses should be lime-washed.

Tallow-Melting.—Fat is melted in the following ways: by a fire beneath the pan, by steam and acid, and by steam jacketed pans. Nuisances may arise from storing the fat, and from the vapours arising from the melting-pan; during the bailing out of the fat from the pan into the vat or strainer; from the general filthy state of the premises. Ballard recommends that the fat should be stored in a closet or chamber communicating with the external air, through a screen of charcoal. The vapours arising from melting the fat should be condensed or burnt. To remedy the nuisances arising from filthy and untidy conditions of premises, cleanliness should be strictly enforced.

Tripe-Boiling.—The nuisance in this case arises from the boiling-pans. These should be provided with lids, with a pipe to convey vapours into the ashpit, or the vapours may be drawn off by a fan, and driven through a furnace fire. After the tripe has been boiled, it should be immediately thrown into cold water, and then it ceases to give off vapour. The building in which the operations are conducted should be well lighted and ventilated, and with an impervious floor. Most scrupulous attention should be paid to cleanliness.

In section XXX. the trades therein specially mentioned have been briefly discussed, but there are many others which might well have been specially mentioned. Local Authorities, however, have power to deal with any such business, trade, or manufacture injurious to health, and I shall allude to a few which are specially liable to be so injurious.

Manufacture of Artificial Manures. — This branch of industry is a very large and important one, and from the great variety of materials used in the preparation of artificial manures, it is impossible to enter into any description of the various processes. The dangers from some of the substances used will be readily understood when it is known that arsenic is found in the vapours arising from their preparation. Other sources of nuisance arise from the storage of offensive materials, bone-boiling, dissolving of leather and shoddy, mixing of fish and shoddy with sulphuric acid, vapours given off from the mixing of materials, and offensive odours from establishment generally.

Manufacture of Glue and Size.—These may cause considerable nuisance to the neighbourhood they are situated in, arising from accumulation of material used, effluvia from steam from boiling-pans, aecumulation of " scutch," and general effluvia, filthy and badly paved and drained yards. There are many other offensive trades which might be referred to, but this section must be concluded by quoting Ballard's general recommendations:—

1. Filth should be removed from the premises speedily in the impervious covered vessels in which it ought always to be collected from time to time during the day.

2. Those parts of the interior of premises liable to become dirty or encrusted with filth or decomposable matters, and all the utensils employed, should be regularly cleansed. Such structural and working arrangements should be made as shall not only tend to prevent sueh defilements, but also tend to facilitate cleansing.

3. Solid refuse should be separated from liquid refuse as far as practicable, and eaeh should be disposed of in its own appropriate manner, the solids being deposited and speedily removed in eovered impervious vessels, and the liquids being run off into proper drains in such a condition as not necessarily to give rise to offensive emanations. Deodorants may sometimes be used with advantage.

4. Offensive matters necessary for use in the business should be brought upon the premises either in covered impervious vessels, or eovered up in such a manner that they shall not be a souree of effluvium nuisance in transit. They should be so received in an enelosed building, and unloaded with due preeaution against the issue of effluvia in the proeess. Offensive

products should be removed similarly from the premises. Precautions should also be used in the removal of offensive products from one part of the premises to the other. Difficulties in this respect now and then arise in works from insufficient space, or bad arrangements of workshops and receptacles. In such cases as these, modifications may be necessary in the works themselves.

5. Offensive materials, and products of the business, should either be stored in impervious vessels or in a close chamber, ventilated, if necessary, in such a manner that the effluvia shall not become a nuisance.

6. Sometimes a careful selection of the materials of the manufacture, or some little modification of the manner of conducting a part of the process, may be sufficient to obviate an effluvium nuisance wholly or partially. But when the evolution of offensive gases or vapours is not thus avoidable, they must be intercepted in their passage to the external air, and dealt with in such a manner as to destroy their offensive character. One method of interception consists in arrangements for drawing off in a continuous manner the air of the entire chamber or workshop in which the offensive effluvia are evolved; but mostly the interception is practicable without doing this. When drawn off or collected, they may, according to their nature, be dealt with in one of five ways,—

(1.) They may be discharged into the atmosphere at such an elevation as that they shall be so diluted before reaching the ground as not to be offensive. When this will not suffice, other means must be used.

(2.) If the evolved matters be condensible by cold, they may be passed through an appropriate condensing apparatus.

(3.) If soluble in water, they may be submitted to the action of water in an appropriate apparatus, or, similarly, to the action of any other liquid better calculated to absorb them.

(4.) Sometimes, in like manner, solid substances, with which the effluvia have chemical affinity, may be used with advantage, either in powder or otherwise.

(5.) If the evolved matters be combustible, they may be burned by conducting them through a fire.

I have quoted the above general recommendations as being of great importance, and which, or some of which, might be found useful in dealing with effluvia in trades not described.

Sanitary Importance of the Subject.

While it is not always easy to point out definitely that certain diseases are caused by the effluvia and other emanations from offensive trades, as many other probable causes have to be eliminated, still it is certain that ill-health is directly and indirectly produced by such causes. There is no doubt that a condition of impaired vitality occurs from, for instance, the breathing of air loaded with offensive organic vapours, from animal or vegetable sources, and such symptoms as loss of appetite, nausea, headache, and general debility occur. Besides those minor ailments, the actual contagia of diseases may be distributed from works where infected articles are used for trade purposes. Workmen are very often sufferers from handling such articles.

Powers and Duties of Local Authorities.

It was found more convenient to group together subsection (E) with section XXX.

For any nuisance arising under subsection (E), application must be made only on medical certificate, or on a requisition in writing under the hands of any ten inhabitants of the district of the Local Authority, and to the Sheriff.

Opinion of Counsel regarding Subsection (E).

"Whether any work, manufactory, trade, or business can be prosecuted for as a nuisance, on an averment and proof that the same is offensive, without an averment and proof that it is injurious to health; and if this question be answered in the affirmative, counsel are requested to state what kind of offensiveness would require to be proved."

Opinion.

"We answer the first branch of the query in the affirmative; and with reference to the second, we find it impossible usefully to say more (speaking generally, and without reference to any particular case) than that the offensiveness must be such as

seriously to interfere with the comfort of life in the neighbourhood, and such as *may* be detrimental to health, although it should be impossible to prove that it had been or necessarily must be so."

This opinion strengthens the hands of Local Authorities when dealing with the various businesses coming under this subsection.

The penalty for infringing or not complying with any decree under this clause is a fine not exceeding five pounds, and not less than two pounds for the first offence, ten pounds for the second, and for each subsequent conviction a sum double the amount in the last preceding conviction; but no penalty shall exceed two hundred pounds.

The form of application to the Sheriff, when made under the hands of not fewer than ten inhabitants of the district, or on medical certificate, should be produced.

Form of Requisition for Subsection (E).

Unto the Local Authority of   the requisition of the undersigned, being not fewer than ten inhabitants of the district of the Local Authority.

We, the undersigned inhabitants of the said district, hereby, in terms of § 16 and 18 of the Public Health (Scotland) Act, 1867, require you, the said Local Authority, to apply to the Sheriff for removal, or remedy, or discontinuance, or interdict of the following nuisance existing within the said district, viz. [*here state the nuisance in terms of section XVI.* (E) *or* (G), *as*, That the manufactory of   , carried on at   , by   , is injurious to the health of the neighbourhood].

Signatures [*mentioning place of residence*].

Instead of the above, a medical certificate may be used similar to the form already given (page 76).

In the trades specified in section XXX., and already referred to, the Local Authority have greater power; for, after the passing of this Act (1867), no such trade or other business, trade, or manufacture injurious to health shall be newly established, or enlarged in any building or place, within any burgh or village, or within five hundred yards therefrom, without the consent in writing of the Local Authority, and published in one or more newspapers circulating within the district. Any dispute regard-

ing any point involved in the section to be settled by the Board, the party dissatisfied to bring the matter before the notice of the Board within twenty-one days after the resolution of the Local Authority has been published.

Any person contravening this enactment to be liable for each offence to a fine not exceeding fifty pounds, in addition to discontinuance of the business in question, with a further penalty not exceeding forty shillings for each day during which the offence is continued.

Local Authorities are empowered to make bye-laws for such businesses as they may think necessary.

Subsect. (F). "*Any house, or part of a house, so overcrowded as to be dangerous or injurious to the health of the inmates.*"

This subject has been already treated, under subsection (A), in dealing with insufficiency of size. It is important to note that the person to be prosecuted in the case of an overcrowded house is the tenant or occupier.

Subsect. (G). "*Any factory, workshop, or workplace, not under the operation of any general Act for the regulation of factories or bakehouses, and not kept in a cleanly state, or not ventilated in such a manner as to render harmless, as far as practicable, any gases, vapours, dust, or other impurities generated in the course of the work carried on therein, and injurious or dangerous to the health of persons employed therein, or any such factory, workshop, or workplace as is so overcrowded, while work is carried on therein, as to be dangerous or injurious to the health of those employed therein.*"

Although this elaborate subsection is included amongst nuisances in section XVI., it is extraordinary that Local Authorities have no power to inspect factories irrespective of the powers they have to deal with bakehouses.

Factories in the subsection which are under a general Act are excluded, and the action of a Local Authority is apparently restricted to simply notifying to the factory inspector under the Factory Act any such condition as above stated in the subsection.

There is reason, however, to hope that this state of matters

will not always be so, and that factories, workshops, etc., will yet be under the supervision of Local Authorities and their officers. Under these circumstances, it will not be out of place to discuss this subsection in the manner of the others.

Factories and Workshops.

Special regulations are provided for these under the Factories and Workshops Acts, and the power of enforcement is vested in special factory inspectors. These have power of entry into the premises, and to prosecute when necessary. It is necessary to explain what is meant by some of the terms used in the Act.

Workshop means "any room or place whatever, whether in the open air or under cover, in which any handicraft is carried on by any child, young person, or woman, and to which and over which the person by whom such child, young person, or woman is employed has the right of access and control."

Factory.—A factory may be either textile or non-textile; the former including all premises wherein or within the close or curtilage of which steam, water, or other mechanical power is used to move or work any machinery employed in preparing, manufacturing, or finishing, or in any process incident to the manufacture of cotton, wool, hair, etc. Non-textile include all other premises where mechanical power is used in aid of the manufacturing process carried on.

In the Acts dealing specially with those industries, the sanitary purposes are the following:—

1. The protection of the public health.
2. (*a*) The protection of the health of the work-people employed.
   (*b*) Their protection from injuries due to the use of dangerous processes or machinery.
   (*c*) The regulation, and in certain cases the prohibition, of the employment of children under the age of 14, young persons between the ages of 14 and 18, and women of whatever age.

To secure the first condition, the factory inspector has to see that the factory or workshop is kept clean, and free from effluvia from any drain, privy, or other nuisance; and if he finds any sanitary defect, it is his duty to inform the sanitary authority in writing, whose duty it is to take the necessary steps under the

Public Health Act. In the Factory and Workshop Acts certain sanitary measures are indicated for securing ventilation, and cleansing by white-washing or oil-painting the walls and ceilings. For the protection of the work-people certain rules have to be attended to, and which depend on the nature of the work carried on,—such as grinding and polishing of steel, where the workshops pre-eminently require to be ventilated by fans to carry away the steel particles; that wet grinding should be adopted instead of dry; and that the workmen should wear masks to intercept particles from being inspired; and in the case of a textile manufactory, where the air becomes polluted by the fine fibrous dust arising from the material used,—such, for instance, as from flax,—the freest ventilation is needed. There are certain trades where the most stringent rules are necessary for the conduct of workmen, to prevent the most pernicious results from the handling of the material used, and its consequent introduction into the system, such as working in lead, mercury, and phosphorus. By attention to these rules, and by improvements in the methods of working, the evil effects have been much reduced.

In the cases shortly referred to, Local Authorities have no powers of inspection; but in a special case—that of bakehouses—they have full powers of inspection.

Provisions of Factory and Workshops Act, 1883–84.

" BAKEHOUSES.

" 15. *Regulations for new bakehouses.*—It shall not be lawful to let or suffer to be occupied as a bakehouse, or to occupy as a bakehouse, any room or place which was not so let or occupied before the first day of June one thousand eight hundred and eighty-three, unless the following regulations are complied with:—

" (i.) No water-closet, earth-closet, privy, or ashpit shall be within or communicate directly with the bakehouse;

" (ii.) Any cistern for supplying water to the bakehouse shall be separate and distinct from any cistern for supplying water to a water-closet;

" (iii.) No drain or pipe for carrying off fæcal or sewage matter shall have an opening within the bakehouse.

" Any person who lets or suffers to be occupied or who occupies any room or place as a bakehouse in contravention of this section shall be liable, on summary conviction, to a fine not exceeding forty shillings, and to a further fine not exceeding five shillings for

every day during which any room or place is so occupied after a conviction under this section.

"16. *Penalty for bakehouse being unfit on sanitary grounds for use as a bakehouse.*—Where a court of summary jurisdiction is satisfied, on the prosecution of an inspector or a Local Authority, that any room or place used as a bakehouse (whether the same was or was not so used before the passing of this Act) is in such a state as to be on sanitary grounds unfit for use or occupation as a bakehouse, the occupier of the bakehouse shall be liable, on summary conviction, to a fine not exceeding forty shillings, and on a second or any subsequent conviction, not exceeding five pounds.

"The court of summary jurisdiction, in addition to or instead of inflicting such fine, may order means to be adopted by the occupier, within the time named in the order, for the purpose of removing the ground of complaint. The court may, upon application, enlarge the time so named; but if, after the expiration of the time as originally named or enlarged by subsequent order, the order is not complied with, the occupier shall be liable to a fine not exceeding one pound for every day that such non-compliance continues.

"17. *Enforcement of law as to retail bakehouses by Local Authorities.*—(1.) As respects every retail bakehouse, the provisions of this part of this Act and of sections three, thirty-three, thirty-four, and thirty-five of the Factory and Workshop Act, 1878 (which relate to cleanliness, ventilation, overcrowding, and other sanitary conditions), shall be enforced by the Local Authority of the district in which the retail bakehouse is situate, and not by an inspector under the Factory and Workshop Act, 1878; and for the purposes of this section the Medical Officer of Health of the Local Authority shall have and exercise all such powers of entry, inspection, taking legal proceedings and otherwise, as an inspector under the Factory and Workshop Act, 1878.

"(2.) If any child, young person, or woman is employed in any retail bakehouse, and the medical officer of the Local Authority becomes aware thereof, he shall forthwith give written notice thereof to the factory inspector for the district.

"(3). An inspector under the Factory and Workshop Act, 1878, shall not, as respects any retail bakehouse, exercise the powers of entry and inspection conferred by that Act, unless he has notice or reasonable cause to believe that a child, young person, or woman is employed therein.

"18. *Construction of Act and definitions,* 41 *and* 42 *Vict. c.* 16.—This Act shall be construed as one with the Factory and Workshop Act, 1878; and in this Act, unless the context otherwise requires,—

"The expression 'retail bakehouse' means any bakehouse or place, the bread, biscuits, or confectionery baked in which are not

sold wholesale but by retail in some shop or place occupied together with such bakehouse.

"19. *Application of Act to Scotland, 30 and 31 Vict. c.* 101.—In the application of this Act to Scotland, the expression 'Local Authority' means the Local Authority within the meaning of the Public Health (Scotland) Act, 1867."

It will be observed that the provisions of section 15 only apply to premises which were not let or occupied as a bakehouse prior to 1st June 1883. The other sections apply to all bakehouses, whether occupied as such before that date or not.

The Board are of opinion that it will be necessary for the due enforcement of the Act that the Local Authority should instruct their medical officer, either personally or by an authorised assistant, to visit and report upon the various bakehouses within the district of the Local Authority. The Local Authority will thus be in a position to take the proper steps for securing that the provisions of the Act are systematically and efficiently enforced.—I am, Sir, your obedient servant, JOHN SKELTON, *Secretary.*

To the Clerk to the Local Authority.

Powers and Duties under Subsection (G).

In this subsection, as in subsection (E), application must be made to the Local Authority by requisition in writing under the hands of any ten inhabitants of the district of the Local Authority; and the penalties for contravention of the decree or interdict are similar to those under this latter subsection.

Subsect. (H). "*Any fireplace or furnace which does not, so far as practicable, consume the smoke arising from the combustible matter used in such fireplace or furnace; and is used within any burgh for working engines by steam, or in any mill, factory, dyehouse, brewery, bakehouse, or gaswork, or in any manufactory or trade process whatsoever.*"

This subsection, it will be observed, only refers to burghs in the case of fireplace or furnace, and that it is only necessary to consume the "smoke as far as practicable." Further on in the Act, it is stated that when the matter is referred to the Sheriff, and it appears to him that the best means then known to be available for mitigating the nuisance, or the injurious effects thereof, have not been adopted, he may suspend his final determination upon condition that the author of the nuisance shall undertake to adopt, within a reasonable and definite time, such

means as he shall judge to be practicable, and order to be carried into effect, for mitigating or preventing such injurious effects. In this subsection, it must be noted that it is the emission of smoke that is the nuisance, not of necessity causing injury to health.

Effects of Smoke.

To understand the effect which smoke has, whether for good or ill, it is necessary to study its composition, and this is found to vary widely, according to the fuel used, the kind of fireplace or furnace, and whether other products than of fuel are discharged with the smoke.

Coal of average composition gives off as carbon and tarry particles,—about 1 per cent. carbon dioxide, carbon monoxide, compounds of sulphur; from $\frac{1}{2}$ to 7 per cent. carbon disulphide, ammonium sulphide, hydrogen sulphide, and water.

An analysis of black smoke by Angus Smith showed the following composition:—

Co^2, . . .	6·17 per cent.
Co, . . .	1·55 „
O, . . .	12·22 „
H, . . .	None.
N, . . .	79·93 „

This shows that there is in black smoke both unburnt carbon and gases.

In many manufactories, besides the smoke issuing from chimneys, there are such poisonous ingredients as arsenic, sulphuric and hydrochloric acids.

In manufacturing cities, the evil effects of pollution of the atmosphere by smoke are evident in the destruction of vegetation, the blackening and disfigurement of buildings, the difficulty of keeping anything clean, the positive discomfort or difficulty of breathing such an atmosphere, and the constant pall which overhangs such cities. If there were no other reasons than the above, they would be sufficient; but there can be no doubt there is actual derangement of health, from the breathing of products such as sulphuretted hydrogen, ammonium sulphide, and carbon disulphide. Besides this, the solid particles in the air derived from chimneys supply the nuclei necessary for the production of

fogs and mists (as described by Aitken), and their injurious effects are only too well known to the bronchitic, asthmatic, and the weak-lunged generally.

The causes of smoke nuisances are described as follows:—

1. Insufficient flue area.
2. Insufficient capacity of main flue.
3. Insufficient chimney capacity to the number of boilers attached.
4. Defective stoking.

The remedies suggested are,—the use of mechanical stokers, Siemens' Regenerative Gas Furnaces, rocking-bars, and air-bridges.

As to the use of mechanical stokers, these are intended to give a slow and continuous supply of coal, and thus to insure better combustion than in the case of ordinary manual firing, where large quantities of fuel are thrown into the furnace from time to time.

Siemens' Regenerative Gas Furnaces are used in steel and glass works. A furnace consists of two or more regenerative furnaces, producing gas which passes up a brick stack, then along wrought-iron tubes to the furnace proper, where both gas and air arrive at a high temperature, caused by passing through heated flues of chequered fire-brick. The inlet and outlet arrangements of the flues are such that when the inlet side becomes cool, it can be reversed, and so become the outlet side; this reversal takes place every thirty minutes; the gas and air are thus continually absorbing a large portion of the waste heat, and giving it out in useful work. The other apparatus referred to are intended to supply more air, so as to insure better combustion of the coal, and are highly spoken of.

Powers and Duties of Local Authorities.

In this subsection application must be made to the Sheriff, and the penalty for contravention of decree or interdict may be five pounds, nor less than two for the first offence, and ten pounds for the second, and for each subsequent conviction a sum double the amount of last fine, but not to exceed two hundred pounds. As mentioned in a former page, the Sheriff has great

discretionary power in dealing with the matter. Practically the question of smoke-abatement is a "dead letter."

Sections CVI. and CVII. of the Public Health Act describe the procedure before the Sheriff in connection with subsections (H), (I), and (J). Appeal may be made to the Sheriff-principal in these cases.

Subsect. (I). "*Any chimney (not being the chimney of a private dwelling-house) sending forth smoke as to be injurious to health.*"

This subsection does not require any lengthy remarks after the previous subsection (H) has been dealt with. It will be noted that dwelling-houses have an immunity under this subsection.

Applications under this section must be made to the Sheriff, and appeal may be made to the Sheriff-principal. The penalties are the same as described under subsection (A).

Subsect. (J). "*Any churchyard, cemetery, or place of sepulchre so situated, or so crowded with bodies, or otherwise so conducted as to be offensive or injurious to health.*" *Besides this clause, Local Authorities have powers under the Burial Grounds (Scotland) Act,* 1855, *if the burial ground or proposed burial ground is or would be dangerous to health, or offensive or contrary to decency.*

The disposal of the dead in a manner that will not be revolting to the feelings of humanity, but with that respect due to the dead, and at the same time securing all the necessary sanitary conditions, is a great social and sanitary question of the day. The burial of the human body in the ground is a practice which has almost been universally observed by Christians, and it has thus come to be looked upon almost as a Christian rite, and not to be displaced by any other system. But whether this method is the best sanitary one has, within recent years, been disputed by many thinkers in the clerical, legal, and medical professions, and by prominent members of society otherwise. The objections to earth-burial occur most prominently in large cities, where the difficulty and expense of obtaining sufficient ground for the purpose become very serious; and the greatest sanitary objections occur there also from pollution of the air,

soil and subsoil water, and the consequent danger to health from diseases both in their infectious and non-infectious forms. Besides, in large cities graveyards are taxed, from this very difficulty in acquiring sufficient land, to their utmost capacity, and too often beyond it, so that they become not only a disgrace to civilisation, but most objectionable and dangerous nuisances in every sense of the word. The remedy, which has been proposed to obviate every objection that can be advanced against earth-burial, is cremation,—destruction of the body by fire,—a process which resolves the body quickly into its elements, not slowly and with danger, as in earth-burial. Space will not permit any further reference to the subject of cremation than the following opinion on it by one of our most distinguished English lawyers, Lord Bramwell, who says: "I think it is right, and what is very rare, with no drawback. It is the cheapest, the most wholesome, and to my mind the least repulsive way of disposing of the dead, and those we have loved. That it is legal, there is not a doubt."

As earth-disposal of the dead is the subject we have to discuss, we will now consider the requirements of a cemetery so as to remove, or at least minimise, the dangers which may occur.

The object in view, when we consign a body to the grave, is to obtain its decomposition, and this occurs just as with every form of organic matter, and with the same evolution of offensive and dangerous products. When the soil is of proper quality, and the body is sufficiently deeply buried, the evolved gases are absorbed and oxidised by the soil, while liquid products are also absorbed. If the body is left undisturbed by no subsequent interments, the process goes on without much if any nuisance being produced; but when, as almost invariably occurs, the grave is opened for another interment, all security is withdrawn, and it must be remembered that a body may take over fifty years for complete decay.

Soil for Cemetery.—To obtain the full advantages of earth-burial, the soil selected should be of an open, porous, pervious nature, freely admitting air and moisture. It should be free from water, and deep draining may have to be resorted to, to get rid of this. There should not be any hard rock to a depth of at least eight feet, and before a cemetery is decided on, trial pits should be made to ascertain the conditions of subsoil water and

nature of soil. Loam and sand with a sufficient quantity of vegetable mould are the best soils; stiff retentive clay, and clay and stones are the worst.

Site for Cemetery.—Nearly every condition should be subservient to secure a site sufficiently far removed from human habitation and from the source of any domestic water supply. It may be assumed that a cemetery, if beyond 200 yards from human habitation, will not act injuriously to health by aerial communication, but the distance it may act through subsoil water in relation to domestic water supply is indefined and probably indefinable. Under these circumstances, the greatest care should be taken to select a site well removed from the neighbourhood of dwelling-houses, or where they are likely to be, and also that the selection is made with due regard to the circumstances connected with subsoil water and its flow. If the cemetery is deeply drained, the same care is necessary to secure that the water flowing from the drains does not reach any domestic water supply. The site should be sufficiently elevated to allow free circulation of winds over it, and nothing should be permitted to prevent this, as high walls or broad belts of trees, although the latter are useful when not closely planted.

Sufficiency of Space.—This is one of the greatest difficulties inseparable from the system, and provided space was without limit, many serious objections to earth-burial would be removed. The size of grave spaces prescribed by the Home Office is 9 feet long by 4 feet broad = 4 square yards for an adult, and for a child under twelve, 6 feet long by 3 broad = 2 square yards. These sizes allow a strip of undisturbed soil round every body.

A minimum space of 1,064 square yards per 1,000 people is recommended, the coffin not to be disturbed for fourteen years. If the body is buried 8 feet deep, and a layer of soil 1 foot thick allowed to remain over it, two other interments might be allowed within fourteen years. The graveyard should be divided into grave spaces with proper marks, and a plan kept. A register of burials, with name, age, and date, should also be kept.

In this subsection (J) the procedure differs from the others in section XVI., as it is not necessary to cite any person as the author of the nuisance. The application must be made to the

Sheriff alone, and he will proceed with it after he has made intimation to the collector of churchyard or other dues, or to such other person as the Sheriff may decide. Such person or persons as shall appear may, if the Sheriff think fit, be allowed to be heard, and object to such application just as if he or they were the author of the alleged nuisance in the meaning of the Act.

The form of petition is the same otherwise as that given under subsection (A), and in this as in all other subsections a medical certificate may be used.

Lastly, it may be advisable to again point out what powers of inspection Local Authorities have, and what procedure must be adopted, in all cases under section XVI. A summary of these will be found on page 73.

CHAPTER XI.

PART III.—PUBLIC HEALTH ACT.

Prevention and Mitigation of Diseases under Order in Council.

The powers which are given to Local Authorities under this part of the Act are only put in force under exceptional circumstances, and by virtue of an Order in Council; without such Order, Local Authorities have no power under this part of the Act.

As stated in the Act, whenever any part of the United Kingdom appears to be threatened, or is affected by any formidable epidemic, endemic, or contagious disease, the Privy Council may by Order or Orders put in force Part III. for the whole or part of Scotland.

The Board of Supervision are then vested with certain powers,—one of which is of so unique a nature, that it may be specially mentioned,—appoint a Sheriff to be an additional member of the Board. We bow to the legal knowledge of the Bar, but we fail to see how such knowledge can affect an epidemic. The Board may further issue certain directions and regulations—

For the speedy interment of the dead.

For house-to-house visitation.

For the dispensing of medicine, and for affording persons afflicted by or threatened by epidemic, endemic, or infectious diseases, such medical aid and accommodation as may be required.

For any such matters or things as may to them appear advisable for preventing or mitigating such disease.

The Local Authority shall attend to such regulations, and may direct prosecution for violating the same.

The Local Authority under this Order have power of entry, at reasonable times in the daytime, to inspect premises, either if they have ground for believing that any person has died of

infectious disease, or that there is necessity to enter the premises to carry out any of the Board's regulations.

When this Order is in force, all houses come under the same regulations as common lodging-houses as regards overcrowding. This must be certified by the sanitary inspector, medical officer, or two qualified medical practitioners. The Order in Council extends to ports and arms of the sea.

PART IV.—PUBLIC HEALTH ACT.

General Prevention and Mitigation of Disease.

Under this Part, Local Authorities, in the ordinary exercise of their duties, are invested with most important powers for not only the prevention of infectious diseases, but for the treatment of cases, with a view to the prevention of their acting as dangerous sources of infection to the general community. The important matters in connection with this part of the subject, and which will be treated fully, are—

The provision of hospitals.
The provision of mortuaries.
The provision of disinfectant apparatus.
The disinfection of infected articles.
The removal of certain persons to hospital.
The provision for vaccination.

Isolation of Infectious Diseases Hospitals.

In the interests of public health and of sanitation, hospitals for the treatment of infectious diseases are of the utmost importance, not only for the patients removed from the insanitary conditions in which they too often are, but in the wider interests of the general community. In the treatment of infectious diseases it is of pre-eminent importance that the patient should be in as nearly as possible perfect sanitary conditions as to air, water, food, and house accommodation; and in well-regulated infectious diseases hospitals these are to be found; but in the overcrowded and generally defective sanitary state of the houses, in which infectious diseases spread with fire-like rapidity, the patients are placed in the most unfavourable condition for the chances of their own recovery, and in the most favourable for the spread

of the disease amongst the surrounding population; but in the case of persons removed to an infectious diseases hospital, the circumstances are exactly reversed, as they are put under conditions most favourable to their recovery, and with the least possible risk to their neighbours from spreading of the disease from which they are suffering.

It may therefore be laid down as a sanitary axiom, that for the effective treatment of infectious diseases, both in the interests of the patient and the community, every sanitary authority should have at its disposal accommodation in an infectious diseases hospital proportionate to the size of the population over which it has control. I advisedly say "accommodation at its disposal," as I am by no means of opinion that every sanitary authority should provide an isolation hospital for its own district, but that there should be an extensive combination of parishes, for the purpose of providing such a hospital, so that it will be complete in every detail as to site, construction, and management, and what is of very great importance, that the burden of expense will by this system of co-operation be reduced to a minimum.

As will be afterwards mentioned more fully, Local Authorities are not compelled to provide such hospitals, and as a consequence, except in towns, very rarely are they provided, except under the stimulus produced by panic, from the outbreak of some dangerous infectious disease, and former experience shows that Local Authorities rush into any expense to provide what should have been ready for use. To obtain the full benefit of an infectious diseases hospital two conditions are necessary—

1*st.* Immediate notification of infectious diseases.

2*nd.* Hospital ready for reception of first case.

We will afterwards refer to the power which has been conferred on Local Authorities by a recent Act of Parliament for the notification of infectious diseases.

Let us briefly refer to the necessary conditions as above stated, and for illustration we may compare the occurrence of an infectious disease in a crowded house or crowded locality to the outbreak of fire. The first case, say of smallpox, is the accidental spark, the members of the household or community are the inflammable materials. If there is immediate notification of this spark sent to the sanitary officials (the fire brigade) by tele-

phone or telegram, they at once appear with their brigade and apparatus, and extinguish the spark by the appropriate means—isolation and disinfection, the latter applied to the inflammable material in contact with the spark; but if there has been no notification, or delayed notification, this inflammable material joins in the conflagration, and the trouble, danger, and cost of the process of extinction will be multiplied; and if, added to this, there is no fire brigade at all (isolation hospital and officials), where the conflagration may end is a question that cannot be answered.

What we have to say regarding hospitals in the following pages, refers solely to those intended for the reception of infectious diseases, and they differ in some important points from ordinary hospitals. It will be most useful to treat of infectious diseases hospitals by taking up each important consideration in detail.

Situation and Site.—There are certain primary conditions necessary which cannot be set aside by others, however important. One of the main objects of infectious diseases hospitals is to isolate the infected person as far as possible from his fellow-beings, so that the situation must be quite clear of human habitations, or even the main roads of traffic; but not so far from the latter as to make conveyance of the patients difficult, or necessitate the making of any great length of new road. In country districts these difficulties can be overcome easily enough; but in towns, to obtain a sufficiently isolated piece of ground is not easy. If the hospital is a combination one, then the situation should be as nearly as possible equally accessible to all the combined areas. In districts bordering on the sea, or on a navigable river, a floating hospital might be constructed, which could be moored in such situations as the occasion demanded. In hospitals where smallpox cases are received, the question of isolation is of the utmost importance, as experience has shown in London and elsewhere that smallpox hospitals have been the means of spreading the disease to the surrounding population,—not by the intercourse of people within and without the hospital, but by aerial communication. In a report to the Local Government Board on the influence of Fulham Smallpox Hospital in thus disseminating the disease, the following facts were observed:—That time after time when this

hospital was open, the disease appeared in excessive amount in its neighbourhood, and the excess always graduated according to proximity of the houses to the hospital, and the area of extension reached to about a mile radius.

In ordinary infectious diseases, however, the danger of their spreading from hospitals to neighbouring houses is apparently little, and the distance need not be more than 100 yards from hospital to human habitation.

In securing a site, the same care should be exercised to obtain a healthy one as has been described in reference to ordinary habitations. An open, porous, dry soil naturally, or rendered so by deep drainage, sufficiently elevated to insure free circulation of air over the ground, and free discharge both of sewers and ordinary drains, and a supply of pure water by gravitation, and in abundance, are most essential conditions. For the sake of convalescents, the site should not be too exposed to cold winds; or advantage may be taken of a belt of trees to break their force, provided the trees are not so close as to cause air stagnation.

Construction of Hospitals.

Hospitals may be included under two headings—

Temporary Hospitals.

Permanent Hospitals.

Temporary Hospitals are generally provided in the case of emergencies, such as the outbreak of smallpox or cholera. In the case of the epidemic of smallpox in Sheffield some time ago, temporary wooden huts had to be run up to meet the large demand for hospital accommodation. Wooden huts do very well for such cases, better than iron huts, as the latter are cold in winter and too warm in summer, but they may be used nevertheless. The most highly recommended temporary hospitals are Doecker's, after their inventor, Captain Doecker of the Royal Danish Army. These portable structures are made of wooden or iron frames, covered with a special kind of felt, lined with canvas. The fastenings of the frames are so arranged that they can be put together in a few minutes, and when not wanted can be taken down and stored for future use. They are warm, and easily kept warm, and make no noise like iron huts. And last, but not least, they are not expensive. Huts should be raised

above the level of the ground, and a trench made round the building to insure dryness. In an outbreak of smallpox, mentioned by Dr. Swete, he had one of those temporary hospitals erected at a cost of £256, including furniture. It was sufficient for eight patients and a nurse. Sir Robert Rawlinson, C.B., C.E., speaks of these hospitals in the highest terms. The agent for these is the Banner Sanitation Company, London.

Permanent Hospitals.—As the name implies, these are made of durable material, such as brick or stone, and may vary in extent and style from the modest cottage hospital to the proportions of the Belvidere Hospital in Glasgow, an institution capable of receiving nearly 400 patients.

The size of a hospital will depend upon the population to be provided for; and the data on which the size in relation to the population is fixed vary somewhat, the Board of Supervision recommending for country districts a bed for every 500 inhabitants, while the Local Government Board recommend one bed for every 1000 inhabitants.

The Board of Supervision, for a population of from 10,000 to 12,000, recommend a hospital of twenty beds, distributed as follows:—Two wards of eight beds each, which might, in case of necessity, be divided so as to form four wards; also two small rooms, each with two beds, for the reception of doubtful cases. In addition, an administrative block, which should be approached by means of a covered passage, and which should contain—(1) a room for the visiting physician, and used also as a surgery; (2) a room for the matron; (3) sleeping accommodation for her, the nurse, and cook; (4) kitchen and scullery; (5) presses for linen and the patients' clothes. Outbuildings, consisting of washhouse, mortuary, disinfecting chamber, and cellarage for coals.

Village Cottage Hospitals.

Accepting the general principle, that every village or combination of villages ought to have ready for immediate use some form of isolation hospital, the question we have to decide is, How can this be provided at once cheaply and satisfactorily? This can be accomplished by having ready a four-room or a six-room cottage, occupied by a husband and wife without any children, and whose services could be utilised by the sanitary authority to act as attendants when needed, or under orders to remove whenever

called upon to do so. These people would act as caretakers of the premises, and for their trouble should reside rent free, or at a moderate rent. In this manner provision is made in the simplest way for any sudden outbreak of infectious disease.

The next form we have to describe is the hospital specially designed for infectious diseases, such as seen in cities, or where districts have combined to form a complete institution.

Hospital Construction.

Every hospital, whether large or small, is made up on the basis of the ward with its adjuncts. The usual plan adopted is the pavilion, with wards on one or two floors; where there is no necessity for economising space, there should only be wards on the ground floor.

While the length of the ward may vary according to circumstances, the breadth should not be more than from 25 to 30 feet. In the Belvidere Hospital each pavilion is 26 feet broad and 168 feet long, outside measurements. From ground level to ridge of roof is 32 feet. In each pavilion there are two wards—one for acute, the other for convalescent cases. For each patient there should be an air space of from 1,500 to 2,000 cubic feet, in the case of adults; for children, 1,200 cubic feet would suffice. The floor space should be about 144 square feet; and to give the necessary cubic space above mentioned for adults, the height of the ward should be 13 or 14 feet from floor to ceiling.

The ward offices may be arranged thus (after Galton): At a corner of one end should be placed water-closet and slop sink, detached from the main building, but with access by a passage with cross ventilation; the water-closet should also be freely ventilated. At the other corner of same end, and cut off in same way as the water-closet, the bath and lavatory should be placed. These should be well ventilated and heated. At the other end of the ward, outside of it, but connected by a passage, the nurse's room and scullery may be placed.

All drains should be ventilated and disconnected in the manner already described in reference to dwellings; and the same precautions must be attended to for preventing damp rising from the soil.

Ventilation may be partly combined with heating by open fire-places, such as Galton's, and by means of windows, of which there

should be one between two beds, opening at top and bottom, or the upper sash to open in a slanting manner upwards. Windows should reach near the level of the ceiling, and there should be about 1 foot of window surface for each 60 cubic feet of ward space. To insure cross ventilation, the windows should be at opposite sides of the ward. In addition to these means, air should be admitted by openings at the floor level beneath the windows, and heated by passing over the warm-water pipes used for heating additional to the open fireplaces. In the ceilings shafts should lead to the ridge, if no ward is above, and be provided with some approved form of ventilating cowl, such as Boyle's. If possible, these shafts should be heated by utilising the heat of the chimney or stove flue. Sheringham valves may be added if necessary. Over each gas jet a small extraction flue should be placed, to carry away products of combustion, and this also materially assists ventilation.

It is of great importance that the floors and walls should not absorb organic matters. The former should be made of hard wood, such as oak, or oak parquetry, or blocks laid on a bed of concrete, with close joints. The floor should not be washed, and to obviate this, should be treated with oil and beeswax, or with paraffin, as formerly described. For cleansing floors treated thus, wiping with a damp cloth and rubbing afterwards is all that is necessary.

For the walls, where expense is no object, tiles may be used with close joints set in cement, or the walls may be oil-painted or lime-washed; and this, if frequently scraped and renewed, answers well. The ceiling may be treated by lime-wash in the same way.

The furnishing of an infectious diseases hospital should be of the simplest description, with the exclusion of anything that is superfluous. There should be no carpets, matting, or curtains. The bedsteads should be iron, with wire-woven mattresses. The beds should be of horse-hair, or as in the Belvidere Hospital, of straw, which is burnt after having been used by one patient, or when soiled. The pillows are filled with chaff.

The principles adopted should be—simplicity, easy cleaning, and absence, as far as possible, of dust-collecting, and thus contagia-collecting, surfaces.

In the bath-room, scullery, and nurse's room, hot and cold water should be laid on, and always ready.

When the hospital consists of two or more pavilions, they

should be connected by corridors, with windows or openings on each side for cross ventilation. The distance between any two pavilions should be at least equal to the height of a pavilion. To secure as much sunlight as possible, the pavilions should run north and south; and to secure free circulation of air round the pavilion, there should be no unnecessary wall, fence, or obstruction of any kind. The utmost attention should be given so that nothing decomposable of animal or vegetable nature is permitted near the building.

As regards the extent of ground for a fever hospital, there cannot be too much, except on the score of expense. Certainly no fever hospital grounds should be less than one acre. Each distinct form of infectious disease should have a special ward, as it is not at all desirable to mix up different types; and in the case of smallpox, not only should there be a special ward, but it should be removed as far as possible from the other wards, and from inhabited buildings generally. In the Belvidere Hospital the smallpox wards are situated in the same grounds as the rest of the wards, but quite separated, so that no communication takes place between them. To obviate the dangers arising from infected air passing out of smallpox wards, it has been suggested that it should first be made to pass through a fire or furnace, and thus all danger of infection would be removed. There is a good deal to be said about this proposal, as the draught which would be caused by such fire or furnace would at the same time ventilate the ward.

It is not desirable that any infectious disease ward should be near human habitations, or that any one, except those in charge of the patients, should come near the grounds, and for this purpose a wall 4 or 5 feet high should surround them. Between this wall and the wards, or where any infected thing is, there should be a free belt of ground at least 40 feet broad. The entrance should be controlled by a porter.

The other buildings necessary in connection with an infectious diseases hospital have been mentioned in the reference to the recommendation of the Board of Supervision regarding infectious diseases hospitals, and as there are no specially distinctive features about these buildings, the mention is sufficient. About such special subjects as mortuaries, disinfecting apparatus, and disinfectants, a tolerably full description is necessary.

Rules for Management of Isolation Hospitals.

The following rules have been used and found to work satisfactorily in an hospital in Warwickshire, and were drawn up by the well-known medical officer of health for that county :—

Rules for Medical Officer, Master, and Matron.—1. The medical officer shall be the responsible head of the establishment, and shall visit occasionally, even when there are no patients, to assure himself that the master and matron are attending to their duties.

2. It shall be the duty of the master and matron to keep the wards scrupulously clean, and to have the bedding well aired and in readiness at all times for the reception of patients. They shall keep an inventory of everything belonging to the hospital, and a careful record of the articles of food and drink supplied to patients by the orders of the medical officer or other medical atttendant. One of them shall always be at the hospital, unless when special leave is granted by the sanitary authority or by their clerk. They shall obey the instructions of the medical officer, and be responsible for the good conduct of nurses and patients.

3. The master shall attend the Board meetings at least once a month, to submit his books, and take orders for necessaries.

Rules for Patients and Friends.—1. No person shall be admitted to the hospital without the production of a certificate signed by a duly qualified medical practitioner.

2. Any patient admitted to the hospital may be attended by any qualified medical practitioner, provided that a request to this effect is submitted to the medical officer or sanitary inspector at the time of admission, and that the cost of such attendance is defrayed by the patient or friends.

3. No visitor shall be allowed inside the building or grounds without written permission from the medical officer.

4. No patient shall leave the wards or take exercise in the grounds without permission from the medical officer or medical attendant.

5. Any patient leaving the hospital without the written permission of the medical officer or medical attendant will be liable to heavy penalties, which will be enforced by the sanitary authority.

6. No patient shall leave the hospital without a change of clothes, unless the clothing used during convalescence has been carefully disinfected.

7. No person in attendance upon patients shall leave the hospital without permission from the medical officer, nor without a change of clothes.

These are simple but very necessary rules, and do not bear hardly on the patients, who are enforced to abide by certain necessary precautions, to prevent infection during convalescence; and also there are certain necessary rules for the observance of visitors.

In such hospitals everything should be done to make it pleasant for patients, as it must be remembered they are bestowing a great boon on their neighbours by thus being isolated, and kind treatment will encourage others to submit to a like quarantine when called upon to do so.

These rules are general in their nature, and further and precise rules would be required to insure that disinfection of all beds and bed-clothing would be carried out, after being occupied, before other cases of a different infective nature should be admitted. Likewise precise rules should be made for the disinfection of rooms, clothing, crockery, etc., which had been in use.

Mortuaries.—A dead-house is necessary for every hospital, and it is desirable in the interests of public health, and we might almost say of public decency, that there should be mortuaries in villages and towns, where the dwellers in the one-room house could remove their dead. "If that one room were your house, what a ghastly intrusion you would be! The bed on which you lie is wanted for the accommodation of the living. The table at which your children ought to sit must bear your coffin, and they must keep your unwelcome company" (Russell, *Life in One Room*).

Mortuaries should be constructed of brick or stone, and situated so that they will not be obtrusive. In the case of hospitals, mortuaries should not be seen from the ward windows. Nor should they be so placed as to lead to any danger of infection proceeding from them.

The room or rooms (in the case of a mortuary for general population) should be lofty, well ventilated, and lighted by

windows on the north side, or if on other sides, external louvred blinds should be provided. Tables for bodies resting on should be made of slate, or if of wood, covered with zinc sheeting, and raised about 3 feet above the ground. In the case of a mortuary for a general population, there should be a room for infectious and another for non-infectious cases. The ceilings and walls should be lime-washed. The floor should be of pavement evenly laid, or of concrete and cement.

In addition to the rooms for the reception of the dead, there must be a room for mourners or visitors to the mortuary, and a shed for shells or other necessary appliances.

Disinfection.—The questions of disinfection and disinfectants are so intimately associated with infectious diseases hospitals, that they may be considered as branches of the subject of isolation hospitals, with which we have been dealing.

It is not necessary here to enter into the theory of infection; but to have a clear comprehension of the use of a disinfectant, it may not be inopportune briefly to refer to what is almost universally held as to the nature of the contagia of infectious diseases. In the first place, it is to be noted that the terms "infectious" and "contagious" are used here as meaning the same thing, and implying that the diseases to which they refer possess the power of communicability.

While it has not been proved in every case of infectious disease what the contagium actually is, it may be accepted as proved that in every case where the contagium has actually been found, as in cholera, typhoid fever, etc., it is a low vegetable organism, endowed with remarkable powers of multiplication, vitality, and resistance to destruction. In the vegetable world the class these organisms belong to is what is called the fission fungi, or schizo-mycetes, including bacteria, bacilli, micro-cocci, etc. All micro-organisms belonging to this class are not disease-producing, or even possessed of dangerous properties; but each kind has apparently its proper part to play in the economy of nature; thus, some produce putrefaction in animal or vegetable substances, some produce fermentation, others produce infectious diseases of the deadly types of cholera, diphtheria, and typhoid fever. The manner in which these different organisms act in the substances or tissues in which they are found, is a subject for a special treatise; and our intention is simply to give the reader a

clear idea of disinfection, and what it aims at; and briefly, a disinfectant is something which can destroy the causes of infectious diseases, viz. the micro-organisms to which we have referred. In this no theory is involved regarding the manner in which the micro-organisms act in producing diseases of any kind, and a disinfectant has a different significance than a mere deodorant, which frequently acts by merely substituting one odour for another. Disinfection may be obtained by—

1*st.* Heat.

2*nd.* Chemical means.

We will now begin by discussing the various methods by which heat is applied to produce disinfection, and the first and most certain of all is destruction of the infected thing by actual fire. This, of course, if universally applied, would be too expensive; but for very soiled articles, or of little value, as the straw used in the beds for fever patients, burning is the best disinfectant. Heat, however, may be applied as a disinfectant without destroying the infected articles, and in several ways: by dry heated air, or air saturated with steam, either at low or high pressure, and by boiling. There are various hot-air disinfecting chambers in the market, and we will briefly refer to a few. Hot-air chambers may be divided into three kinds—1. Those in which heat is applied outside; 2. those in which heated air is blown inside; 3. those in which the products of combustion enter.

Fraser's Disinfector is made of brick, and is heated by a coke oven. A small fireplace is provided to burn sulphur, and the fumes are allowed to enter the chamber. A portable oven is made by the same makers.

Scott's Disinfector is made either in a fixed or portable form, and is heated by coal or gas. The chamber is composed of hollow panels filled with non-conducting material. There is an apparatus for regulating the supply of gas.

Ransome's Stove is a cubical iron stove cased in wood, with intervening layers of felt. The furnace is placed at the sides on a lower level. The heated air containing the products of combustion passes along a horizontal flue, and enters the chamber at the bottom. The heat is well distributed in the inside, but the chamber is difficult to heat. In all forms of hot-air disinfectors there is a danger of scorching the articles inside. And another

great objection to dry heat as a disinfectant is its deficient penetration; and for thick articles of clothing or bedding a very long exposure is necessary, and even then it is not certain that thorough penetration of heat so as to insure disinfection has been effected. The following experiments were performed by Koch to test the penetration of garments by dry heat. In a hot-air stove a thermometer was placed,—one in the centre of a roll of linen thirty-two times wound round, and one between each four rolls, and the temperature of the air in the oven and the temperatures indicated in the rolled-up thermometers were compared.

Temperature of stove at	2	P.M.	was	227° F.
	3	"	"	293°
	4	"	"	298°
	5	"	"	302°
	6	"	"	298°

Reading of thermometer in rolled-up linen—

In middle of roll, . .	94°
4 turns from middle, . .	109°
8 " " . .	126°
12 " " . .	152°
16 " " . .	165°
20 " " . .	175°
28 " " . .	212°

It will thus be seen that a temperature sufficient to scorch on the outside most kinds of clothing would penetrate very little into bulky articles.

The temperature in a disinfecting apparatus should not exceed 250° F. to avoid injury to the articles enclosed. The following will show the effect of different degrees of heat on various articles:—

Woollen articles change colour after six hours' exposure at 212° F., or after two hours at 220° F.

Cotton and linen change colour after six hours at 257° F.; fine fabrics begin to scorch at 255° to 260° F. A temperature of 212° F. fixes stains in fabrics, and to prevent this articles should first be steeped in cold water.

Disinfection by Steam.

One of the best forms of apparatus by this method is Lyon's Patent Steam Disinfector. This consists of a strong elliptical iron chamber with double walls of boiler plate, and a door at each end. These doors are closed by screws, so that they render the chamber air-tight. Steam is supplied by a boiler, and it can be made to enter either the hollow walls of the chamber, in which case dry air disinfection is obtained in the interior, or the steam is made to enter both the hollow walls and the interior; and to obtain a temperature of 250° F. a pressure of two atmospheres is needed, giving the means of disinfection by high pressure steam.

Dr. Parsons, who conducted a series of experiments on disinfection by heat, stated that Lyon's Steam Disinfector gave the best results.

This inquiry of Dr. Parsons and its bearing on public health are so important that a summary of his results will not be out of place here.

Disinfection by Heat, Summarised Results, from Dr. Parsons' Report.

1. It may be assumed that the contagia of the ordinary infectious diseases of mankind are not likely to withstand an exposure of an hour to dry heat of 221° F., or one of five minutes to boiling water or steam at 212° F.

2. Dry heat penetrates very slowly into bulky and badly conducting articles, as of bedding and clothing, the time generally employed for the disinfection of such articles being insufficient to allow an adequate degree of heat to penetrate into the interior.

Steam penetrates far more rapidly than dry heat, and its penetration may be aided by employing it under pressure, the pressure being released from time to time so as to displace the cold air in the interstices of the material. In hot air the penetration of heat is aided by the admixture of steam, so as to moisten the air, but hot moist air did not appear to have a greater destructive effect upon spores of anthrax bacilli than dry heat.

3. Scorching begins to occur at different temperatures with different materials, white wool being soonest affected. It is

specially apt to occur when the heat is in the radiant form. To avoid risk of scorching, the heat should not be allowed much to exceed 250° F., and even this temperature is too high for white woollen articles.

4. By a heat of 212° F. and upwards, whether dry or moist, many kinds of stains are fixed in fabrics so that they will not wash out. This is a serious obstacle in the way of employment of heat for the disinfection previous to washing of linen, etc., soiled by the discharges of the sick.

5. Steam disinfection is inapplicable in the case of leather, or of articles which will not bear wetting. It causes a certain amount of shrinkage in textile materials, about as much as an ordinary washing. The wetting effect of the steam may be diminished by surrounding the chamber with a jacket containing steam at a high pressure, so as to superheat the steam in the chamber.

6. For articles that will stand it, washing in boiling water (with due precautions against re-infection) may be relied on as an efficient means of disinfection. It is necessary, however, that before boiling, the grosser dirt should be removed by a preliminary soaking in cold water. This should be done before the linen leaves the infected place.

7. The objects for which disinfection by dry heat or steam is specially applicable are such as will not bear boiling in water, *e.g.* bedding, blankets, carpets, and cloth clothes generally.

8. The most important requisites of a good apparatus for disinfection by heat are, (*a*) that the temperature in the interior shall be uniformly distributed; (*b*) that it shall be capable of being maintained constant for the time during which the operation extends; and (*c*) that there shall be some trustworthy indication of the actual temperature of the interior at any given moment. Unless these conditions be fulfilled, there is risk, on the one hand, that articles exposed to heat may be scorched; or, on the other hand, that through anxiety to avoid an accident the opposite error may be incurred, and that the articles may not be sufficiently heated to insure their disinfection.

9. In dry-heat chambers, the requirement (*a*) is often very far from being fulfilled, the temperature in different parts of the chamber varying sometimes by as much as 100°. This is especially the case in apparatus heated by the direct application

of heat to the floor or sides of the chamber. The distribution of temperature is more uniform in proportion as the source of heat is removed from the chamber, so that the latter is heated by currents of hot air rather than by radiation.

10. In chambers heated by gas, when once the required temperature has been attained, but little attention is necessary to maintain it uniform, and in the best made apparatus this is automatically performed by a thermo-regulator. On the other hand, in apparatus heated by coal or coke, the temperature continually tends to vary, and can only be maintained uniform by constant attention on the part of the stoker.

11. In very few hot-air chambers did the thermometer with which the apparatus was provided afford a trustworthy indication of temperature of the interior: in some instances there was an error of as much as 100° F. This is due to the thermometer, for reasons of safety and accessibility, being placed in the coolest part of the chamber, and the bulb being endorsed for protection in a metal tube, which screens it from the full access of heat. The difficulty may be overcome by using, instead of a thermometer, a pyrometer actuated by a metal rod across the interior of the chamber.

12. In steam apparatus, the three requirements above mentioned are all satisfactorily met, and for this reason, as well as on account of the greater rapidity and certainty of action of steam, steam chambers are, in my opinion, greatly preferable to those in which dry heat is employed.

13. Without wishing to give the preference to one maker over another, I may mention of the apparatus heated by coal, Bradford's newer Machine; of those heated by gas, the Nottingham Self-regulating Disinfecting Apparatus; and of those employing steam, Lyon's Patent Steam Disinfector, in my experiments, gave the best results of any in their respective classes.

14. It is important that the arrangement of the apparatus, the method of working, and the mode of conveyance to and fro, should be such as to obviate risk of articles which have been submitted to disinfection coming into contact with others which are infected.

This last suggestion is a very important one; and to insure that articles which have been disinfected will not come into contact with infected articles, the following arrangements are necessary.

In such an apparatus as Lyon's Disinfector there are two doors, one at each end. To take advantage of this, so as to secure that there will be no mixing of infected and disinfected garments, one end of the apparatus should open into a room where the infected articles are, and the other open into a room where the disinfected articles will be removed from the disinfector, and stored till they are required. An intervening partition isolates the one room from the other, the disinfector standing midway.

Disinfection by Boiling.

In the absence of such special forms of disinfectant apparatus as have been described, it should never be forgotten that there is always close at hand a very reliable form of disinfection, viz. by boiling water. Articles which can stand this without undue injury to their texture, should first be steeped in cold water with or without the addition of a disinfectant, and then placed in boiling water for about ten minutes. This length of period for ordinary micro-organisms seems long enough, but to obtain absolute sterilisation it has been shown by Professor Tyndall that repeated boilings on successive days are necessary.

Chemical Disinfectants.

The second part of the subject of disinfectants deals with chemical methods; and with the flood of light that has been thrown within recent years on the true nature of the actual contagia of infectious diseases, many substances formerly believed to be genuine disinfectants have been found to be quite useless, and others must be used in enormous quantities, and for a lengthy period, to be of use, so resistant are some micro-organisms, specially those that are spore-bearing, to such disinfectants.

For the disinfection of the sick-room the only aerial disinfectant that can be used is pure air, and as much as possible of this should be supplied to the patient. It is on this principle that infectious diseases hospitals are constructed, as regards ward space, in the interest both of the patient and of the attendants. A free supply of air dilutes and oxidises to a certain extent infective particles. It is futile to attempt disinfection of the air by fumes of sulphur or chlorine gas, as the patient would succumb before the contagia could be destroyed. Attempts at disinfection in this direction should aim at absolute cleanliness of

everything in the ward and room, removal of discharges and excreta as quickly as possible, absence of anything which tends to obstruct the free passage of air about the ward or the patient. Those remarks, of course, apply only to disinfection of the air while a patient is present, as chemical disinfectants applied in the proper way are of the utmost importance, and this will be afterwards described.

There are several varieties of gaseous disinfectants in use, and we will briefly refer to those which are considered most useful, viz. chlorine, sulphurous acid, nitrous acid, and ozone.

Sulphurous Acid or Sulphur Dioxide may easily be prepared by burning sulphur, such as roll sulphur. For this purpose no special apparatus is necessary. A shovel with live coals on it acts well enough, the sulphur being placed on the coals; an apparatus with spirit of wine may be used; or a more refined method, by means of cones supplied by the Carbon Cone Company. The quantity of sulphur used should be large, from 1 lb. to $1\frac{1}{2}$ lb. for every 1,000 cubic feet of space to be disinfected. Besides acting as a germicide, sulphurous acid decomposes sulphuretted hydrogen and combines with ammonia.

Chlorine Gas. — This is given off when chloride of lime is moistened. The quantity of chlorine used must be very large, and to obtain a sufficient amount to disinfect 1,000 cubic feet of space, it is recommended to use 22 lbs. of hydrochloric acid, and 15 lbs. of chloride of lime; and to have the room previously filled with steam, this materially assisting the disinfecting action.

Chlorine may also be evolved by adding four parts of strong hydrochloric acid to one part powdered manganese dioxide, or four parts common salt and one part of manganese dioxide are mixed with two parts by weight of sulphuric acid and two of water, and heated gently.

Chlorine decomposes hydrogen and ammonium sulphides. Iron articles in a room should be smeared with vaseline, to protect them against the action of chlorine.

Nitrous Acid can be evolved by acting on copper with nitric acid and water. It is a most powerful oxidiser of organic matter, and is useful for disinfecting mortuaries.

Ozone.—This allotropic form of oxygen is a powerful oxidiser, and may be prepared by mixing gradually three parts of strong sulphuric acid and two parts of permanganate of potassium.

The practical application of these disinfectants will be better dealt with in treating of the purification of a room in which there has been a case of infectious disease.

Liquid Disinfectants.

Many liquids have been used as disinfectants; but few are now retained as being reliable to fulfil the requirements of a thorough disinfectant, viz. to destroy the organisms and spores of diseases. From the extensive experiments of Koch and others, fullest reliance is placed on a 1 to 1,000 solution of bichloride of mercury; but its intensely poisonous action is a drawback, and it should be coloured in some way to prevent it being mistaken for something else. A solution can be made thus: $\frac{1}{2}$ ounce of corrosive sublimate, 1 fluid ounce of hydrochloric acid, and 5 grains of commercial aniline blue in 3 gallons of common water. This quantity can be made for about threepence, and is useful for swabbing floors and woodwork, and for steeping sheets, handkerchiefs, and such like; but they should be steeped in common water for some hours before being washed.

For the same purposes strong solutions of carbolic acid are also used; and for fine articles a solution of the pure crystals (1 in 20) may be used; while for other purposes 1 pint of crude carbolic in 2 gallons of water will suffice.

Creolin has lately come into use as an antiseptic and disinfectant; but enough is not known about it to warrant its application.

Iodate of Calcium.—Dr. Klein, experimenting with disinfectants on behalf of the Local Government Board, found this substance had valuable disinfectant qualities.

For a reliable chemical disinfectant, however, we know of no better than a 1 to 1,000 solution of bichloride of mercury.

Solid Disinfectants.

Amongst these, charcoal, earth, quicklime, and chloride of lime are most useful. To disinfect the walls and ceilings of an infected house: after scraping off the old whitewash, they should be coated with limewash, containing four teacupfuls of chloride of lime to the pail of limewash; of course the addition of water makes this a liquid disinfectant. For the disinfection of discharges or excreta, chloride of lime should be freely used; but

more reliable is the solution of bichloride of mercury, already described.

Charcoal, especially animal, has a great power of deodorising and oxidising organic matters. But of course, as a disinfectant, its action must necessarily be limited; as an air purifier, however, there is no doubt of its power; and perhaps the modern tendency of disinfection aims too much at germ destruction to the exclusion of means by which the effluvia from fermentations and putrefactions are rendered non-offensive and harmless. It must always be kept in view, that if actual disease is not caused by offensive smells, still these are offensive, and render people who are inflicted by them liable to actual disease by lowering their vitality. Modern ideas regarding the action of micro-organisms in causing disease, attribute greater effects to their products—ptomaines and leucomaines—than to the actual organisms; and oxidants may act by destroying these products.

Disinfection of Infected Room.

Having briefly explained some of the processes for disinfecting clothing, bedding, etc., it will be now necessary for me to explain what means should be adopted to disinfect and cleanse a room that has been occupied by a person suffering from an infectious disease.

It is usual, in the first place, to employ some method of aerial fumigation, and for this purpose roll sulphur should be used by the methods already explained, and in the quantity stated—about $1\frac{1}{2}$ lbs. for every 1,000 cubic feet of room to be disinfected. Before doing so, every opening and chink in the room should be closed. Any infected articles of clothing or bedding should be freely exposed, to take advantage of the disinfecting action of the sulphurous acid. After the process has begun, the room should be closed for at least six hours, and after that the windows and doors should be opened for twenty-four hours, to allow free ventilation. Such articles of clothing as can be boiled should be thus disinfected, or by steeping in some of the solutions already referred to, or sent to the sanitary authorities' disinfecting chamber. Articles which are much soiled should be burnt. Mattresses and heavy articles cannot be disinfected at home, and should be sent to the disinfecting chamber, when this is at disposal.

The paper should be removed, and the walls scraped if limewashed, and again freshly papered or limewashed. All wooden articles and floors should be washed with the 1 to 1,000 mercurial solution. In the case of death from an infectious disease, the body should be wrapped up in a sheet saturated with this solution, screwed down in the coffin, and buried as quickly as possible. Where a mortuary exists, the Local Authority should take advantage of the power they then have, and order the removal of the body there.

Disinfection of Drains, Cesspools, etc.

The necessity for disinfecting these should not occur, as it implies imperfect construction or management, and remedial measures are indicated to put them in order, rather than attempts at disinfection. Disinfectants in these cases must be used in enormous bulk, to obtain the necessary strength; where heaps of manure or other filth are found, before removal they might be covered over with earth and quicklime. Foul cesspits, etc., might be treated with sulphate of iron or crude carbolic acid; but greater reliance should be placed on efficient and continuous sanitary supervision than any such unsatisfactory attempts at disinfection.

Powers of Local Authorities for Prevention and Mitigation of Disease.

As described under section XXXIX. of the Public Health (Scotland) Act, 1867, Local Authorities have power to provide within their district hospitals or temporary places for the reception of the sick. They may build an hospital, provided the Board approve of the situation and construction. Two or more contiguous Local Authorities may combine in providing a common hospital. Along with the application to the Board for approval of a proposed hospital, the Local Authority should transmit a plan of the buildings, on which the number of beds and the number of cubic feet in each apartment should be marked, and an Ordnance Survey map, showing the proposed site, a plan of the drainage works, and information as to water supply, etc. etc. Where such a hospital or place for the reception of the sick is provided, the sheriff, magistrate, or justice may, on application of the Local Authority, with consent of the superintending body of such

hospital or place, by order on a certificate signed by a legally qualified medical practitioner, direct the removal, at the cost of the Local Authority, of any person suffering from any dangerous, contagious, or infectious disease, and being without proper lodging or accommodation, or lodged in a room occupied by others besides those in attendance on such person, or being on board any ship or vessel; or may direct the removal from the room occupied by such person of all others not in attendance on him, the Local Authority providing suitable accommodation for such other persons.

No. 10.—*Certificate by Medical Practitioner for Removal of Sick Persons where a Hospital or Place for the Reception of the Sick exists, with Procedure thereon, sect. 42, or for Removal of other Persons.*

CERTIFICATE BY A LEGALLY QUALIFIED MEDICAL PRACTITIONER.

[*Place and date.*]

I hereby certify, on soul and conscience, that is at present suffering from a [*insert dangerous, or contagious, or infectious, see sect.* 42] disorder, viz. and is [without proper lodging or accommodation; *or*, lodged in a room occupied by others besides those in attendance on him; *or*, is on board the ship or vessel lying at].

Signature.

CONSENT BY THE SUPERINTENDENT OF A HOSPITAL OR PLACE FOR THE RECEPTION OF THE SICK EXISTING WITHIN THE DISTRICT OF THE LOCAL AUTHORITY OF .

[*Place and date.*]

I [*state his name and office, and the hospital or place for reception of the sick*], consent to the reception in the said of mentioned in the foregoing certificate.

APPLICATION FOR WARRANT.

[*Place and date.*]

I, , sanitary inspector of the district of , hereby, in terms of sect. 42 of the Public Health (Scotland) Act, 1867, crave a warrant for the removal of the said to the said .

OR,

[*Place and date.*]

I, , sanitary inspector of the district of ,

hereby, in terms of sect. 42 of the Public Health (Scotland) Act, 1867, crave a warrant and direction to remove from the room occupied by the said of all others not in attendance on him, the Local Authority providing suitable accommodation for such other persons.

ORDER.

[*Place and date.*]

I, [*sheriff, magistrate, or justice*], hereby direct the removal by the said Local Authority of the said to the said at the cost of the said Local Authority.

OR,

[*Place and date.*]

I, [*sheriff, magistrate, or justice*], hereby direct the removal by the said Local Authority from the room occupied by the said of all other persons not in attendance on him, the Local Authority providing suitable accommodation for such other persons.

Means for Disinfection.

In section XL. it is stated that a Local Authority may provide a proper place, with all necessary apparatus and attendance for disinfection of infected articles, and may cause such articles to be disinfected free of charge. The Local Authority is empowered to provide a carriage or carriages suitable for the conveyance of cases of infectious disease, and to convey persons so affected to hospital or to their own homes free of charge.

Disinfection of Houses by Local Authority.

Upon medical certificate, if the Local Authority think that cleaning and disinfecting of a house, or part of a house, or articles therein, would tend to prevent or check infectious diseases, it shall be the duty of the Local Authority to give notice in writing, requiring the owner or occupier of the house or part of a house to cleanse and disinfect, within a specified time, under a penalty not exceeding twenty shillings for every day he continues to make default. Further, they may do the necessary processes themselves, and charge the owner and occupier with the expense. If the latter are too poor, the Local Authority may do the cleansing and disinfection at their own expense.

No. 8.—*Medical Certificate for disinfecting House, etc., and Notice thereon, sect.* 40.

CERTIFICATE BY A LEGALLY QUALIFIED MEDICAL PRACTITIONER.

I hereby certify, on soul and conscience, that the cleansing and disinfecting of the [*describe the house or part of house*] situated at and occupied by and of the [*state articles requiring to be disinfected*] therein contained, would tend to prevent or check the spreading of a contagious or infectious disease, viz. of which [a case *or* cases] recently occurred therein [*state when patient removed, or other particulars*].

NOTICE BY THE LOCAL AUTHORITY OF TO [*occupier or owner*].

[*Place and date.*]

You are hereby required immediately to cleanse and disinfect the premises and articles mentioned in the foregoing certificate, in terms of sect. 40 of the Public Health (Scotland) Act, 1867, and that under the penalty and subject to the consequences therein contained.

Sanitary Inspector.

CERTIFICATE OF SERVICE.

I, , certify that I served a notice, of which the foregoing is a copy, on therein mentioned, on the day of at o'clock .M., by [*state the mode of service, sect.* 10] in presence of the undersigned witness, viz.,

, *witness.*

Provision of Mortuary.

Local Authorities have power under section XLIII. of the Act to provide a mortuary ; and when there is one, and any dead body from infectious disease is retained in a room in which persons live or sleep, or any dead body in such a state as to endanger the health of the inmates of the same house or room is retained in such house or room, the sheriff, magistrate, or justice may, on medical certificate, order by a writing under his hand the body to be removed to such proper place of reception at the cost of the Local Authority, and direct the same to be buried within a specified time ; and unless the friends and relations of the deceased undertake to bury the body within the prescribed time, it shall be the duty of the Local Authority to bury such body. Unclaimed dead bodies have to be buried by the Local

Authority, the expense of which may be recovered from any person legally liable for such expenses of burial.

Medical Certificate for Removal of Dead Body to Mortuary.

[*Place and date.*]

I hereby certify that   died on or about   , and that he died of an infectious disease, viz.   , and the body is retained in a room in which persons live or sleep; or the dead body is retained in the house [*or* room] [*describe it*], and is in such a state as to endanger the health of the inmates of that [house *or* room], and that the body ought to be buried [this day (*or other time specified*)].

ORDER FOR REMOVAL.

[*Place and date.*]

I, [*sheriff, magistrate, or justice*], hereby, in terms of sect. 43 of the Public Health (Scotland) Act, 1867, order the before-mentioned dead body to be removed to the place of reception for dead bodies within the district of the said Local Authority, by or at the cost of the said Local Authority, and to be buried within   .

Penalty for Letting House or Room where Infectious Cases have been lodged without Disinfection.

In section L. it is stated that if any person knowingly lets any house or room or part of a house where there has been a case of infectious disease, without first having disinfected the premises and articles therein to the satisfaction of a qualified medical practitioner, as testified by his certificate lodged with the sanitary inspector or his deputy, such person shall be liable to a fine of twenty pounds. A Hotel or Inn is included.

Provisions as to Common Lodging-houses.

See Chapter XII. page 223 *et seq.*

Provision as to Ships.

A ship under this Act comes under the definition of premises, and under section LII. any ship, except belonging to Her Majesty or any Foreign Government, lying in any river or harbour or other water, shall be subject to the Local Authority of the district within or *ex adverso* of which such river, harbour, or other water is situate. Any ship within three miles of the coasts of Scotland shall be deemed to be within the district of a Local Authority.

Any Local Authority may, with the sanction of the Board,

lay down rules for the removal to hospital of any person suffering from infectious disease brought to their district by ship, and may detain them as long as necessary. The Local Authority may by these rules impose a fine of five pounds on any one infringing them.

Section LVI. states that every ship having on board any person affected with a dangerous, infectious, or contagious disease, shall be deemed to be within the provisions of the Act of sixth year of King George the IV. chap. 78.

Penalties for exposing of Infected Persons.

In section XLVIII. it is stated that if any person suffering from an infectious disease shall enter, or any person in charge of a person so suffering shall place such person in any steamboat, sailing vessel, railway carriage, stage coach, hackney carriage, or other public conveyance without previously notifying the owner or person in charge thereof that such person is so suffering, the person so contravening this provision shall, on conviction before any sheriff, magistrate, or justice, be liable to a penalty not exceeding five pounds.

No owner or person in charge of any public conveyance shall be bound to carry any person so suffering.

In the following section it is stated,—

"Any person suffering from any infectious disease who wilfully exposes himself, without proper precaution against spreading the said disease, in any street, public place, or public conveyance, and any person in charge of one so suffering who so exposes the sufferer, and any owner or person in charge of a public conveyance who does not immediately provide for the disinfection of his conveyance after it has, with the knowledge of such owner or person in charge, conveyed any such sufferer, and any person who, without previous disinfection, knowingly gives, lends, sells, transmits, or exposes any bedding, clothing, rags, or other things which have been exposed to infection from such disorders, shall, on conviction of such offence, before the sheriff, or any magistrate or justice, be liable to a penalty not exceeding five pounds: Provided that no proceedings under this section shall be taken against persons transmitting with proper precautions any such bedding, rags, or other things for the purpose of having the same disinfected."

Notification of Infectious Diseases.

In addition to the powers which have now been described, Local Authorities have by recent legislation obtained additional and most necessary powers to deal with infectious diseases by the passing of the Infectious Diseases (Notification) Act, 1889. This Act is only compulsory as regards London, but may be adopted in Scotland. When a Local Authority resolves to adopt this Act, fourteen days' notice must be given to every member: and if the resolution is adopted, it must be published by advertisement, handbills, and otherwise, for the information of interested parties. An interval of not less than a month must intervene before the Act comes into operation, and a copy of the resolution must be sent to the Board of Supervision.

The diseases to which the Act applies are "small-pox, cholera, diphtheria, membranous croup, erysipelas, the diseases known as scarlatina or scarlet fever, and the fevers known by any of the following names: typhus, typhoid, enteric, relapsing, continued or puerperal." With the approval of the Board of Supervision, any other infectious disease may be added, either temporarily or permanently.

The following is the procedure to be adopted:—

(1.) Where an inmate of any building used for human habitation within a district to which this Act extends is suffering from an infectious disease to which this Act applies, then, unless such building is a hospital in which persons suffering from an infectious disease are received, the following provisions shall have effect, that is to say,—

(*a*) The head of the family to which such inmate (in this Act referred to as the patient) belongs, and in his default the nearest relatives of the patient present in the building or being in attendance on the patient, and in default of such relatives every person in charge of or in attendance on the patient, and in default of any such person the occupier of the building, shall, as soon as he becomes aware that the patient is suffering from an infectious disease to which this Act applies, send notice thereof to the medical officer of health of the district:

(*b*) Every medical practitioner attending on or called in to visit the patient shall forthwith, on becoming aware that the patient is suffering from an infectious disease to which this Act applies, send to the medical officer of health for the district a certificate stating the name of the patient, the situation of the building, and the

infectious disease from which, in the opinion of such medical practitioner, the patient is suffering.

(2.) Every person required by this section to give a notice or certificate who fails to give the same, shall be liable on summary conviction in manner provided by the Summary Jurisdiction Acts to a fine not exceeding forty shillings:

Provided that if a person is not required to give notice in the first instance, but only in default of some other person, he shall not be liable to any fine if he satisfies the Court that he had reasonable cause to suppose that the notice had been duly given.

Vaccination.

This important subject is dealt with under special statute, but is also referred to in the Public Health (Scotland) Act, 1867, in regard to Local Authorities defraying the cost of vaccination in certain cases. The working of the Vaccination Act is not committed to the Local Authority, but to the Parochial Board and the Board of Supervision, and this anomalous state of matters has not been altered in the Local Government Act. Under section LVII. of the Public Health (Scotland) Act, 1867, Local Authorities, however, have the power to offer free vaccination in such cases as may appear necessary. In the event of a threatened epidemic of small-pox this power should at once be taken advantage of, and vaccination and revaccination should not only be recommended, but every facility should be given to have these carried out quickly and thoroughly. Vaccination stations should be opened in every village; at which place the medical officer of health, or vaccinator, should be prepared to vaccinate every one applying for this preventive measure. Vaccination, to be efficient, must be done in the most careful manner, and the following recommendations issued by the Local Government Board, in regard to efficient vaccination, will be found useful.

Instructions for Vaccinators under Contract.

(1.) Except so far as any immediate danger of small-pox may require, vaccinate only subjects who are in good health. As regards infants, ascertain that there is not any febrile state, nor any irritation of the bowels, nor any unhealthy state of skin; especially no chafing or eczema behind the ears, or in the groin, or elsewhere in folds of skin. Do not, except of necessity, vaccinate in cases where there has been recent exposure to the infection of measles

or scarlatina, nor where erysipelas is prevailing in or about the place of residence.

(2.) In all ordinary cases of primary vaccination, make such insertions of lymph as will produce at least four separate good-sized vesicles or groups of vesicles, not less than half an inch from one another. The total area of vesiculation on the same day in the week following the vaccination should be not less than half a square inch.

(3.) Direct that care be taken for keeping the vesicles uninjured during their progress, and for avoiding afterwards the premature removal of the crusts. Do not use any needless means of "protection" or of "dressing" to a vaccinated arm; but if, in a particular case, you find reason for means of "protection" or of "dressing," define the material and the manner of use of the appliance best adapted to the case, avoiding all such as cannot readily be destroyed and replaced whenever they become soiled.

(4.) Enter all cases in your register on the day when you vaccinate them, and with all particulars required in the register up to and including the column headed "Initials of person performing the operation." Enter the results on the day of inspection. Each of those entries must be attested by the initials of the person who inspects the case. In cases of primary vaccination, register as "successful" only those cases in which the normal vaccine vesicle has been produced; in cases of revaccination, register as "successful" only those cases in which either vesicles, normal or modified, or papules surrounded by areolæ, have resulted. When any operation (whether vaccination or revaccination) has to be repeated owing to want of success in the first instance, it should be entered as a fresh case in the register.

(5.) Endeavour to maintain in your district such a succession of cases as will enable you to vaccinate with liquid lymph directly from arm to arm at each of your contract attendances; and do not, under ordinary circumstances, adopt any other method of vaccinating. To provide against emergencies, always have in reserve some stored lymph; either *dry* on ivory points, thickly charged and constantly well protected from damp; or *liquid*, in fine, short, uniformly capillary (not bulbed) tubes, hermetically sealed at both extremities. Lymph, successfully preserved by either of these methods, may be used without definite restrictions as to time. With all stored lymph caution is necessary, lest in time it have become inert, or otherwise unfit for use.

(6.) Consider yourself strictly responsible for the quality of whatever lymph you use or furnish for vaccination. Never either use or furnish lymph which has in it any, even the slightest, admixture of blood. In storing lymph be careful to keep separate the charges obtained from different subjects, and to affix to each set of charges

the name, or the number in your register, of the subject from whom the lymph was derived. Keep such note of all supplies of lymph which you use or furnish as will always enable you to identify the origin of the lymph. Do not employ lymph supplied by any person who does not keep exact record of its source.

(7.) Never take lymph from cases of revaccination. Take lymph only from subjects who are in good health, and, as far as you can ascertain, of healthy parentage; preferring children whose families are known to you, and who have elder brothers or sisters of undoubted healthiness. Always carefully examine the subject as to any existing skin disease, and especially as to any signs of hereditary syphilis. Do not take lymph from children who have any sort of sore at or about the anus. Take lymph only from well characterised, uninjured vesicles. Take it at the stage when the vesicles are fully formed and plump. Do not take it from a vesicle around which there is any conspicuous commencement of areola. Open the vesicles with scrupulous care to avoid drawing blood. Take no lymph which, as it issues from the vesicle, is not perfectly clear and transparent, or which is thin and watery. From a well-formed vesicle of ordinary size do not, except under circumstances of necessity, take more lymph than will suffice for the immediate vaccination of five subjects, or for the charging of seven ivory points, or for the filling of three capillary tubes; and from larger or smaller vesicles, take only in like proportion to their size. Never squeeze or scrape or drain any vesicle, and do not use lymph that has run down the skin. Be careful never to transfer blood from the subject you vaccinate to the subject from whom you take lymph.

(8.) Scrupulously observe in your inspections every sign which tests the efficiency and purity of your lymph. Note any case wherein the vaccine vesicle is unduly hastened or otherwise irregular in its development, or wherein any undue local irritation arises; and if similar results ensue in other cases vaccinated with the same lymph, desist at once from employing it. Consider that your lymph ought to be changed if your cases, at the usual time of inspection on the day week after vaccination, show any conspicuous areolæ round their vesicles.

(9.) Keep in good condition the lancets or other instruments which you use for vaccinating, and do not use them for any other purpose whatever. When you vaccinate, have water and a napkin at your side, with which invariably to cleanse your instrument after one operation before proceeding to another. Never use an ivory point or capillary tube a second time either for the conveyance or for the storage of lymph; but when points or tubes have once been charged with lymph and put to their proper use, do not fail to break or otherwise destroy them.

By attention to the foregoing rules all the objections which have been adduced against the process of vaccination are shorn of their power, and vaccination will yield, in the hands of its performers, the fullest benefit which this great discovery has conferred on mankind. That ill effects have occurred from vaccination cannot be doubted, but the principle should not be blamed for this; some defect in the manner of its performance, or some infraction of the rules which must be attended to, should be looked for as the cause.

Within recent years the question has been raised whether vaccination should be made compulsory or not, and those who range themselves on the side of optional vaccination have adduced all kinds of objections to vaccination, some of which have no foundation in fact, others have some show of reason. The most reasonable objections are those which refer to the occasional bad effects of the operation; but, as has been already explained, these can be avoided with a little care. The other objection, and which has never been proved to have any foundation in fact, is that there is no benefit to be derived from vaccination. Statistics and proof have again and again been brought forward to disprove this assertion, sufficient to convince the greatest sceptic; but those who do not wish to be convinced never will be convinced. That the stand which has been made against vaccination is of considerable influence must be admitted, seeing that a Commission is now inquiring into the whole question; but the supporters of vaccination view this inquiry with satisfaction, as they wish the truth to be made known, and the public to be fully enlightened on the whole subject.

Since the introduction of vaccination, for fifty-five years there have been at the rate of twenty-four epidemics of small-pox for one hundred years, while previous to inoculation there were about seventy epidemics in one hundred years. Before the introduction of vaccination few people escaped small-pox. In hospital experience the mortality of unvaccinated persons ranges from 37·2 to 64·2 per cent., and of the vaccinated from 8·7 to 12 per cent.

There is a close relationship between the number of vaccination marks and the degree of protection from severe small-pox. The following table from statistics of the London Small-pox Hospital shows the relationship :—

Cases of Small-pox.	Number of Deaths per cent.
Unvaccinated, . . .	$35\frac{1}{2}$
Vaccinated, but no mark, . .	$21\frac{3}{4}$
One mark, ...	$7\frac{1}{2}$
Two marks, ...	$4\frac{1}{8}$
Three marks, ...	$1\frac{3}{4}$
Four or more, . . .	$\frac{3}{4}$

Amongst the ignorant great misconception prevails as to what vaccination is intended to do, and vaccinators should endeavour to educate the uninformed on this point, pointing out that vaccination does *not* confer *absolute* immunity from small-pox, but most certainly insures that if they incur an attack it will be modified and slight, and that the sufferer will not run the same risk of dying as in unmodified small-pox. In the case of vaccination during an epidemic it should be explained, that if a person has been vaccinated within three days subsequent to exposure to the contagion of small-pox the latter may develop, but in a modified condition ; and if within two days, probably small-pox will be entirely avoided.

It must further be explained, that extended experience and statistical information point to revaccination being necessary about the age of twelve years, as the protective influence wears away with the lapse of time.

CHAPTER XII.

(PART V.—PUBLIC HEALTH (SCOTLAND) ACT, 1867.)

Regulation of Common Lodging-houses.

It may be asked why so much attention and so stringent rules are applied to common lodging-houses, and to understand the reason it is necessary to inquire into the conditions that were found existing prior to such stringent legislation dealing with this subject.

It must be remembered that the dwellers in such houses are the nomadic and more or less irresponsible members of society, free from the cares and responsibilities of the possessors of a fixed place of abode, and equally free from the virtues and habits and customs which we expect from their more fortunate brethren who dwell in houses of their own. A lawless class thus seeking shelter would not be too particular in their selection of house accommodation, or about the character of the proprietor of the lodging-house, and thus we would have massed together a lawless, dangerous class of people in wretched houses, and subject to the extortionate claims of an unprincipled landlord. The massing of people together in any case is a source of danger to their own health, but what concerns the outside world most, to the public health, for the influence radiates to the community at large. When to this is added the fact that in such houses fevers of all descriptions arose and attained extreme violence, we can readily understand how the question of the regulation of common lodging-houses evolved itself into a question of State duty; and by this Public Health Act, 1867, Local Authorities were endowed with very full powers to deal with the subject, and which will now be referred to.

In section LIX. it is stated that a Local Authority must keep a register, in which the names and residences of keepers of common lodging-houses will be entered, also the situation of the

house, and the number of people authorized to be kept in each room. The Local Authority have power to refuse to register any person as a common lodging-house keeper who does not produce a certificate of character, signed by three householders of the parish assessed for relief of the poor. The Local Authority have power, subject to approval of the Board, to raise or diminish the sum payable per night, but not to exceed sixpence per night.

By section LX. a house must be inspected and registered prior to being used as a common lodging-house, and the following section deals with evidence of registration.

Section LXII. deals with the power of Local Authorities to make rules and regulations for such houses. Such rules and regulations, when confirmed, must be printed and furnished gratis to keepers of common lodging-houses, who shall place a copy in each room where lodgers are kept.

Section LXIV. deals with the question of water supply; and if a house is not sufficiently well supplied, a Local Authority may require the owner or keeper to obtain the same within a reasonable time, under risk of the house being removed from the register. In the next section power is given to Local Authorities to order keeper to report every person who resorted to the house during the preceding day or night.

In section LXVI. an important power is given to Local Authorities, viz. to remove sick persons to hospital on medical certificate that the disease is infectious and the person can be removed. The Local Authority may cause clothing and bedding to be disinfected or destroyed, and may give compensation for injury or destruction of such articles. By the next section the keepers of common lodging-houses are compelled to notify infectious diseases occurring in their houses, and the medical officer must then visit and report on the case.

Keepers of common lodging-houses must allow their premises to be inspected by any officers of the Local Authority.

Section LXIX. is important, and is given here as in the Act:—

"The keeper of a common lodging-house shall thoroughly cleanse all the rooms, passages, stairs, floors, windows, doors, walls, ceilings, privies, ashpits, cesspools, and drains thereof, to the satisfaction of the inspector, and so often as shall be required by, or in accordance with, any regulation of the Local

Authority, and shall well and sufficiently, and to the like satisfaction, limewash the walls and ceilings thereof in the first week of each of the months of April and October in every year, and at such other times as the Local Authority may, by special order, appoint or direct."

The last section states, that when the keeper of a common lodging-house is convicted of a third or any subsequent offence under this Act, the Local Authority may withdraw his licence for five years, or grant on special conditions.

In the following pages will be found copies of regulations for common lodging-houses, which were approved of by the Board of Supervision; such approval is necessary where regulations dealing with common lodging-houses are contemplated.

Rules and Regulations for Common Lodging-house recommended by the Board of Supervision.

1. No house shall be used as a common lodging-house unless such house shall have been inspected and approved for that purpose by the inspector of common lodging-houses, and shall have been registered by the Local Authority.

2. All applications to have a house registered as a common lodging-house shall be in writing, and shall truly set forth the name and residence of the applicant, the situation of the house, the number of the rooms, the number of lodgers proposed to be accommodated, and the number of applicant's family, and shall be accompanied by a certificate of character, in such form as the Local Authority shall direct, signed by three inhabitant householders of the parish respectively assessed for the relief of the poor.

3. If the Local Authority are satisfied with the character of the applicant, and with the fitness of the premises, they may register accordingly, and shall furnish the keeper with a register ticket for each room of such common lodging-house, setting forth the number of lodgers to be accommodated in such room; and every keeper of a common lodging-house shall keep hung up in some conspicuous place in each room the register ticket for such room, along with a copy of these rules and regulations, and shall not wilfully deface or destroy the same, or permit them to be defaced or destroyed.

4. No keeper of a common lodging-house shall permit any room in such house to be occupied by a greater number of persons than the number specified in the register ticket, which shall be in the proportion of not more than one person for every 300 cubic feet of space contained in such room. Two children under ten years of age may be counted as one person.

5. No keeper of a common lodging-house shall permit males and females above ten years of age to occupy the same sleeping apartment, except in the case of husband and wife.

6. Every keeper of a common lodging-house shall enter in a book to be kept by him the name and designation, and the dates of arrival and departure, of each lodger.

7. All rooms, lobbies, passages, and stairs in every common lodging-house shall be properly ventilated to the satisfaction of the Local Authority. A window of every room shall be made so as to open, and shall be kept open for two hours in the morning and two hours in the afternoon of every day, unless prevented by bad weather or the illness of any lodger; and during the hours when the windows are open, the bed-clothes of every bed shall be turned down and exposed to the air.

8. Every keeper of a common lodging-house shall provide sufficient bedsteads and bedding, a proper supply of pure and wholesome water, and suitable accommodation for cooking and washing, together with towels and all necessary utensils for the requirements of the lodgers, all to the satisfaction of the Local Authority.

9. Every keeper of a common lodging-house shall cause all bed-clothes and bedding, and all articles and utensils in such house, to be kept in a thoroughly clean and wholesome condition.

10. Every keeper of a common lodging-house shall cause the floors of every apartment, and of every lobby, closet, passage, and stair in such house, and also the common stairs and lobbies by which access is obtained thereto, to be thoroughly swept every day before the hour of ten in the forenoon, and to be thoroughly washed once in every week; he shall thoroughly cleanse all the rooms, passages, stairs, floors, windows, doors, walls, ceilings, privies, ashpits, cesspools, and drains thereof to the satisfaction of the inspector, and so often as shall be required by, and in accordance with, any regulation of the Local Authority, and shall well and sufficiently, and to the like satisfaction, limewash

the walls and ceilings thereof, in the first week of each of the months of April and October in every year, and at such other times as the Local Authority may by special order appoint or direct.

11. Every keeper of a common lodging-house shall cause all ashes and night soil, and all solid or liquid filth or refuse, and all offensive matter or thing, to be removed from such house every day before the hour of ten in the forenoon; shall not allow any dangerous or offensive animal, or any poultry, to be kept or fed in such house; shall cause all water-closets, privies, and ashpits belonging to such house to be maintained in good order and in wholesome condition; and shall cause any yard, area, or court in connection with such house to be regularly swept, and kept in a clean and wholesome condition.

12. When any person in a common lodging-house is ill of fever, or any infectious or contagious disease, the keeper of such house shall give immediate notice thereof to the medical officer, or to the inspector of common lodging-houses, or to the inspector of poor, and shall act in accordance with any instructions which he may receive from the medical officer or other officer of the Local Authority.

13. Every keeper of a common lodging-house shall, immediately after the removal, recovery, or death of any person who may have been ill of fever or any infectious or contagious disease within such house, cause every part of the room which may have been occupied by such person to be thoroughly cleansed and disinfected, and shall also cause all clothes, bedding, and other articles in such room to be thoroughly cleansed and disinfected, unless the Local Authority shall have ordered the same to be destroyed.

14. Every keeper of a common lodging-house shall at all times give free access to such house, and to every part thereof, to all officers of the Local Authority and all officers of police.

15. Every keeper of a common lodging-house shall refuse to admit into such house any person in a state of intoxication, or of known bad character; shall maintain and see to the enforcement of good order and decorum within such house; and shall prevent any persons occupying or resorting to such house for immoral purposes.

16. Any person offending against any of these rules and

regulations shall be liable in a penalty not exceeding the sum of five pounds for each offence; and in the case of a continuing offence, in a further penalty not exceeding the sum of forty shillings for each day after written notice of the offence from the Local Authority.

No. 13.—*Notice by the Local Authority to provide Water to a Common Lodging-house, sect.* 64.

NOTICE TO PROVIDE WATER TO A COMMON LODGING-HOUSE.

The Local Authority of hereby give notice to you [*state name and designation, and add,* owner *or* keeper, *as the case may be*], of a common lodging-house at , and hereby require you, within from the date of service hereof, to obtain a proper supply of water for the use of the lodgers in said common lodging-house [*add here, if necessary,* And to execute all works necessary for that purpose], otherwise the Local Authority may remove the said common lodging-house from the register until it be complied with; all in terms of sect. 64 of the Public Health (Scotland) Act, 1867.

CERTIFICATE OF SERVICE.

I, , certify that I served a notice, of which the foregoing is a copy, on therein mentioned, on the day of at o'clock .M., by [*state mode of service; as,* By putting the same into the Post Office at addressed (*give address*); *or,* Delivering it to him personally at the premises, etc.], in presence of the undersigned witness, viz.,

, *witness.*

No. 14.—*Notice to the Keeper of a Common Lodging-house to report to the Local Authority, etc., sect.* 65.

NOTICE TO THE KEEPER OF A COMMON LODGING-HOUSE TO REPORT TO THE LOCAL AUTHORITY, ETC.

The Local Authority of hereby order and require you, , keeper of a common lodging-house at , to report to daily for the next days, every person who resorted to the said house during the preceding day or night; and, for that purpose, daily to fill up and transmit as aforesaid one of the schedules, of which copies are herewith furnished to you; all in terms of sect. 65 of the Public Health (Scotland) Act, 1867.

Sanitary Inspector.

CERTIFICATE OF SERVICE.

I, , certify that I served a notice, of which the foregoing is a copy, and also copies of the schedule therein mentioned, on therein mentioned, on the day of at o'clock .M. [*state mode of service; as,* By putting the same into the Post Office at addressed to him (*give address*); *or,* By leaving the same with him personally at the premises, etc. (see sect. 110)], in presence of the undersigned witness, viz.,

, *witness.*

No. 15.—*Certificate by Medical Officer, or qualified Medical Practitioner, as to Removal of Patient from a Common Lodging-house, sect.* 66.

CERTIFICATE BY MEDICAL OFFICER OR QUALIFIED MEDICAL PRACTITIONER.

[*Place and date.*]

I, [medical officer of the district of , *or* legally qualified medical practitioner], hereby certify that presently residing in the common lodging-house kept by at is ill of , and that his disease is infectious or contagious, and that the patient may be safely removed.

Houses let in Lodgings.

We have dealt with the subject of common lodging-houses, and pointed out the powers Local Authorities have to deal with these. The difference between common lodging-houses and houses let in lodgings will be easily understood by reference to the definition of the first already given.

The section dealing with houses let in lodgings is XLIV. of the Act, and it is therein stated that, with consent of the Board, Local Authorities in any burgh or populous place, containing at last census not less than 1,000 inhabitants, may make regulations for such houses. The proposed regulations and the notice of the intention to apply for the consent of the Board must be published in one or more newspapers circulating in the district for one month.

The following are the matters which can be dealt with :—

"1. For fixing the number of persons who may occupy a house or part of a house which is let in lodgings or occupied by members of more than one family.

"2. For the registration of houses thus let or occupied in lodgings.

"3. For the inspection of such houses, and the keeping the same in a cleanly and wholesome state.

"4. For enforcing therein the provisions of privy accommodation or water-closet accommodation, and other appliances and means of cleanliness in proportion to the number of lodgings and occupiers, and the cleansing and ventilation of the common passages and staircases.

"5. For the cleansing and limewhiting at stated times of such premises.

"6. For the enforcement of the above regulations by penalties not exceeding forty shillings for any one offence, with an additional penalty not exceeding twenty shillings for every day during which a default in obeying such regulations may continue."

Rules for Cellar Dwellings.

Section XLV. deals with vaults or cellars used for human habitation, and which are partly or in whole below the level of the surrounding ground. It is provided—

"It shall not be lawful to let separately, except as a warehouse or storehouse, or to suffer to be occupied as a dwelling place, any cellar whatsoever, or any vault or underground room (not being entirely open on one or other of its sides), which vault or room shall be less in height from the floor to the ceiling than 7 feet in the case of houses built prior to the passing of this Act, or less in height than 8 feet in the case of houses built subsequently to the passing hereof, or which shall be less than $\frac{1}{3}$ of its height above the level of the street or ground adjoining the same, or otherwise shall not have 3 feet at least of its height from the floor to the ceiling above the said level, with an open area of 2 feet 6 inches wide from the level of the floor of such vault or room, up to the level of the said street or ground, or which shall not have appurtenant thereto the use of a water-closet or privy and ashpit, or which shall not also have a glazed window made to open to the full extent of the half thereof, the area of which is not less than 9 superficial feet clear of the frame, and a fireplace with a chimney or flue; or which vault or underground room being an inner or back vault or cellar let or occupied along with a front vault or room as part of the same letting or occupation, has

not a ventilating flue (unless such inner or back vault or room shall be part of a house built before the passing of this Act), or which shall not be well and effectually drained by means of a drain, the uppermost part of which is 1 foot at least below the level of the floor of such vault, cellar, or room after the Local Authority have given notice to the owners thereof that the letting of such cellars, vaults, or underground rooms as dwelling-places is prohibited from that time forth; and it shall be the duty of the Local Authority to issue such notices from time to time, as soon as is convenient, until such notice has been given with respect to every cellar, vault, or underground room occupied as a dwelling-house within the district; and it shall not be lawful after such notice to let or continue to let, or to occupy or suffer to be occupied separately, as a dwelling-house any such cellar, vault, or underground room."

Any one who lets any such places, or who knowingly suffers to be occupied for hire as dwelling-houses, contrary to the provisions of this Act, shall be liable in a penalty not exceeding twenty shillings for every day during which vault, cellar, or room is so occupied after conviction of the first offence. Any two convictions within three months, whether the persons so convicted were the same or not, may lead to temporary closure of the premises by order of the sheriff, magistrate, or justice; and the Local Authority may be empowered to permanently close them, in such manner as they may deem fit.

Notice to the Owners of Underground Dwellings.

NOTICE.

The Local Authority of hereby give notice to you, owner of the vaults, cellars, or rooms following, viz., That in terms of sect. 45 of the Public Health (Scotland) Act, 1867, the letting of the foresaid premises as a dwelling place or dwelling places is prohibited from and after the date hereof under the penalties provided by the said Act. This notice given on the day of .

CERTIFICATE OF SERVICE.

I, , certify that I served a notice, of which the foregoing is a copy, on therein mentioned, on the day of at o'clock .M., by [*state the mode of service, sect.* 110], in presence of the undersigned witness.

, *witness.*

CHAPTER XIII.

UNSOUND FOOD.

In section XXVI. of the Public Health Act, the subject of unsound food is referred to in the following words:—"The sanitary inspector may at all reasonable times enter any premises to inspect and examine any carcase, meat, poultry, game, flesh, fish, fruit, or vegetables exposed for sale, or which there is probable cause for believing to be intended for human food; and in case any such carcase, meat, poultry, game, flesh, fish, fruit, or vegetables appear to him to be unfit for such food, the same may be seized without any warrant; and if it appear to the sheriff, or any two magistrates or justices, that any such carcase, meat, poultry, game, fish, fruit, or vegetables are unfit for the food of man, he or they shall, by a writing under his or their hand or hands, order the same to be destroyed, or to be so disposed of as to prevent the same being exposed for sale, or used for such food; and the person to whom such carcase, meat, poultry, game, flesh, fish, fruit, or vegetables belong, or in whose custody the same are found, shall be liable to a penalty not exceeding ten pounds for such carcase, piece of meat, or flesh, or for any quantity of fish, poultry, game, fruit, or vegetables, or any refuse thereof, and also to pay all expenses caused by the seizure, detention, or disposal thereof."

This section is one of the most important in the Act, and the powers conferred on Local Authorities to deal effectively with the grave offence of selling or trying to sell unsound food should be taken advantage of to the fullest extent, consistent with these powers. It has long been recognised that many human diseases have their origin in food supplies, and modern research and experience not only have confirmed this view, but have added many other diseases so caused to the list. There are further powers conferred upon Local Authorities to deal with foods

which have been adulterated, and the Act dealing with this subject will be referred to.

In the section of the Public Health (Scotland) Act, 1867, as quoted, it will be seen that the duty of examining the various articles named therein falls upon the sanitary inspector, who may at all reasonable times enter any premises for this purpose. It must be specially noted that the articles must be exposed for sale, or that there is probable cause for believing that they are intended for the food of man; and in any case if they appear to him to be unfit for such food, they may be seized without any warrant. The sanitary inspector has no power to destroy any articles seized unless by an order in writing from the sheriff, justice, or magistrate.

Upon the sanitary inspector, by this clause, a most delicate and difficult duty is imposed, and one which can only be satisfactorily performed by a highly trained and conscientious official, thoroughly conversant with the appearances of healthy and unhealthy foods from careful study and practical acquaintance with the subject. The knowledge of the subject which he possesses should not alone be confined to the various articles mentioned; he should also know what diseases of animals render their flesh unfit for food, and what are the physical signs in the living animal by which he would form an opinion as to the nature of such diseases. Here the functions of the veterinary surgeon are infringed on, and it is highly desirable that every fully equipped sanitary authority should have available the services of a consulting veterinary surgeon. Although by this section the duty of examining articles of food devolves upon the sanitary inspector, it is always understood that he should in case of need call in the services of the medical officer, and in the instructions issued by the Local Government Board for the guidance of sanitary inspectors this is specially mentioned.

In the following pages a brief description will be given of certain diseases of animals which render them unfit to be used for human food, and of the appearances presented by diseased conditions of various articles of food.

Diseases of Animals.

Epizootic pleuro-pneumonia has attracted much notice from its unfortunate wide-spread occurrence. This disease must not be

confounded with ordinary pleuro-pneumonia, which is a non-infectious inflammatory disorder, while the former variety is infectious, and is in reality a fever. At the commencement of the disease it may be impossible to detect it in the affected animal, and as it is often very insidious, a long time may elapse before the characteristic symptoms show themselves; then the animal begins to look ill, shivers, loses appetite, and the coat begins to "stare;" cough may be present, but is not a marked symptom; when those symptoms are present, the thermometer will be found to be elevated to about 102° F. or above, and this elevation of temperature is a most important sign. As the disease progresses, emaciation increases, appetite diminishes, the cough becomes more marked, and respiration becomes more laboured and quicker, and the animal shows great distress—its head stretched forward, the back arched, and the hind limbs drawn under the body. Diarrhœa usually sets in, and all the symptoms become aggravated till the animal dies or is killed.

As regards physical signs in the chest, these at the first are as little marked as the symptoms, but later on there is great tenderness over the walls of the chest, and especially over the shoulders; pressure there causes the animal to wince, and show much distress. Upon percussion, dulness will be found to an extent depending on the intensity of the affection; on listening with the ear or stethoscope, the rubbing or friction sounds characteristic of pleurisy will be heard unless effusion into the chest cavities prevents this being heard; along with friction sounds there are heard coarse and fine crepitations, characteristic of inflammation of the lungs.

Post-mortem Appearances.—These are probably of more importance to sanitary officials than the symptoms of the disease. The appearances will vary with the duration of the disease and its consequent extent.

In the early stages the lining membranes of the chest—the pleuræ—will be found reddened and congested, with flakes of lymph on the surface. There may be a quantity of fluid in the chest. In this early stage the lung substance will be congested and consolidated in diffused patches. In advanced cases the chest may be found filled with a watery fluid or purulent matter. The lungs may be found bound down to the chest wall by strong fibrous adhesions between the two pleural surfaces, and the

pleuræ will be found considerably thickened. The lungs in advanced cases will be found heavy and consolidated from the development of an enormous amount of fibrous tissue, and a piece of this will sink in water, showing its increased density. The flesh is darker, and not so well fed as it should be, and very often the carcase will be of a badly nourished animal.

To avoid detection by sanitary officials, butchers usually strip off the pleuræ from the chest walls, and smear them over with fat.[1] It has not been shown that eating the flesh of animals which have suffered from this disease causes any ill effects, and enormous quantities of the flesh from animals which have been so affected pass into the market, and it is a matter of opinion whether such flesh is fit for human food or not. Under the General Police and Improvement (Scotland) Act, 1862, such flesh as coming from a diseased animal would be condemned.

Cattle Plague.

Rinderpest, or cattle plague, is a disease which affects both cattle and sheep, and is contagious. When the animal becomes affected, the temperature rises from two to three degrees. Soon an eruption appears on the mucous membrane of the mouth and other mucous surfaces. When the animal is thoroughly affected, its head droops, breathing is oppressed, twitching of the muscles occurs, and rigors, while a discharge issues from the eyes, nose, and mouth. Great prostration ensues, the animal is often unable to stand on its feet, and death usually results in about a week from the commencement of the disease.

Post-mortem Appearances.—The most important is congestion of the various mucous membranes, and of the fourth stomach particularly; the epithelium is denuded. Emphysema of the lungs is common. The spleen is usually healthy. The flesh is dark, flabby, crackles, and has a disagreeable smell. Although no bad effects have been proved to be due to the ingestion of such flesh, it certainly should not be used for human food.

Foot and Mouth Disease. Murrain.

This highly infectious disease affects sheep, cattle, pigs, and even human beings. After a short incubation period, during which the temperature rises, the characteristic appearances are seen, viz. the formation of vesicles, varying in size from a pea to

a half-crown, on the tongue, lips, roof of mouth, and udder in cows. Vesicles also appear between the digits and around the heels, causing great pain and lameness. Sometimes the hoof is detached from the foot. A copious discharge of saliva occurs from the mouth, and the animal is unable to masticate food, but is thirsty, and readily drinks cold water. The animal usually recovers.

Post-mortem Appearances are mainly to be found in the mucous surfaces affected, and are the characteristic vesicles and denuded epithelium; in the feet, vesicles, loosened or detached hoofs, and sloughing sores. The flesh does not present any abnormal appearances usually.

Anthrax. Charbon.

This extremely virulent disease attacks cattle, sheep, pigs, and human beings, producing in the latter two distinct forms—malignant pustule and woolsorter's disease. Different authorities adopt different classifications of the disease, but simply two distinct forms may be recognised,—

1. Charbonous fever without eruption.
2. Charbonous fever with eruption.

In the former a variety of the disease occurs called splenic apoplexy, where the animal affected may die suddenly without any previous symptoms. Usually the following symptoms occur:—Loss of appetite, cessation of rumination, rigors, cold sweats, great prostration, embarrassed respiration. Sometimes the tissues of the back crackle on touching. The eyes are red and injected, the mouth filled with mucus and blood. In the pig a red flush and red spots appear on the ears, and blotches on the skin; vesicles and ulcerations may appear.

Charbonous Fever with Eruptions.

In this form tumours appear in various situations, such as in the neck and loins. They are painful, and the tissues crepitate on touching them. On the mucous membrane of the mouth large tumours may be found, and also on the walls of the abdomen. In calves a variety of anthrax is frequently met with, which goes by the name of quarter ill. In this variety swellings form on the neck, loins, limbs, etc., which crepitate when

touched, from the formation of gases under the skin, due to decomposition of extravasated blood.

Post-mortem Appearances.—The carcase is usually engorged and tumefied, abdomen distended with gas, extravasations under the skin and into the substance of the muscles. Tumours are found on the skin, mouth, etc. Glands swollen. The spleen is enormously increased in size and weight, and on cutting into it we may only see a mass of blood.

The characteristic feature of the disease is found by microscopic examination of the blood, or of any of the affected tissues, where the well-known micro-organism the Bacillus anthracis, will be found.

The flesh of animals which have suffered from anthrax should be unhesitatingly condemned, and destroyed by cremation, if possible.

Tuberculosis.

Diseases associated with the presence of tubercle are common to man and the lower animals, and pathologists look upon such diseases in whatever animal they occur as identical. Since Koch's discovery that tubercular diseases are due to a micro-organism,—the Bacillus tuberculosis,—such diseases have been looked on as communicable between animals affected and sound animals; and what is of much importance at this time, that the flesh of animals which have been affected with tubercular disease may develop a similar disease, under certain circumstances, in the human being. The fact of this communicable nature of the disease is of much greater importance, when we now know that not only may such diseases be communicated by ingestion of the flesh, but that cows, which are particularly liable to the affection, may, when the udder is infected, convey the disease through the medium of their milk. Even before the demonstration by Koch of the bacillus of tubercle, and its causal relationship to the disease, it was known that milk could convey the disease; but when we now consider that the organism is the cause of tubercular disease, and that it can be found in the milk of cows with tubercular udders, the question whether any part, or the milk, of an animal which has been affected with tuberculosis should be used for human food is of the first importance. There cannot be another opinion but that it would be highly dangerous to

use for food a piece of flesh actually the seat of tubercle; but whether the whole carcase of an animal should be condemned because, for instance, the lungs were affected, is a matter of opinion. A recent important decision in Glasgow, by Sheriff Berry, held that animals so affected were unfit for the food of man. This decision has the support of the leading medical and veterinary authorities in Scotland.

If flesh is thus rendered unfit for food, the case of milk is a much stronger one, as this article of diet is largely used without any boiling or cooking, and thus there is no destruction of the bacilli, as occurs when flesh is boiled or roasted.

During life great difficulty is often experienced in diagnosing tuberculosis, as the animals may be in the very best condition, or they may be in the most emaciated state, when they are called "piners" or "wasters." When the disease affects the lungs, cough and the physical signs by percussion and auscultation will usually indicate the true nature of the disease.

Post-mortem Appearances.—The presence of the little nodules, called tubercle, is the characteristic sign. These may be found in the lungs, pleuræ, glands, peritoneum, etc. These nodules are variously called "grapes" and "angle berries," from their imagined resemblance to these fruits. By the aggregation of nodules immense tumours may be found in the chest, abdomen, and other situations. On microscopic examination, the characteristic giant cells and bacilli will prove the true nature of the disease.

Trichinosis.

This disease affects numerous warm-blooded animals, but its chief interest is that the domestic pig is liable to the disease, and the human being becomes affected from eating its infected flesh. The mature parasite Trichina Spiralis is found in the intestinal canal, where it soon develops embryos, which soon begin to wander and pass through the intestines into the abdomen, and from there into the muscular system of the host, and at an early period may be found in the diaphragm and intercostal muscles; but soon they wander into more distant muscles over the body. In the muscles they finally become encysted, and there characteristic appearances may be found. To the naked eye they appear as small specks, whitish in appearance, and running in the direc-

tion of the muscular fibres. By rupturing the cyst, turning out the trichina, and staining it with picro-carmine, it will be distinctly seen under the microscope. In the larval form it is about $\frac{1}{25}$ of an inch long, and in the cyst lies coiled up, giving rise to a corkscrew-like appearance.

To discover the trichina in affected muscles, the latter should be hardened in Müller's fluid, thin sections cut, and stained with picro-carmine. Under a low power microscope ($\times$ 50) the cyst will be seen between the muscular fibres, which near the cyst may be compressed, and inside the cyst the coils of the parasite will be found. The adult male is about $\frac{1}{18}$ of an inch long, and the female may be double this.

Pig Typhoid or Hog Cholera.

In this disease the pig is feverish, restless, and breathes quickly, and an eruption appears on the skin, which may be red or blue, giving rise in the former case to what is called "red soldier," and in the latter "blue soldier."

The flesh of animals which have been affected with this disease should not be eaten.

Strangles is a disease which attacks pigs. The throat becomes red and swollen, and the swelling may spread to the shoulders. There is difficulty of breathing and swallowing.

Variola Ovina (Sheep Pox).

This is a contagious disease, and occurs in a virulent and mild form. The first signs are little papules or nodules, with a red colour, in the skin; there may also be a diffuse redness. The skin from these marks has a flea-bitten appearance. The papules enlarge and become vesicles, at first containing a clear fluid, but afterwards turbid, finally drying into a scab. In bad cases the skin ulcerates and the wool falls off. The disease renders the carcase unfit for food.

Variola Vaccinia (Cow Pox).

A contagious disease, with a characteristic eruption. When the animal becomes infected, after a latent period of six to nine days the teats become swollen and tender, and small hard pimples form. They assume a red hue, and in three or four days become as large as beans. They rise in the centre, and

become pointed; clear fluid at first appears, but it afterwards becomes turbid. The pustules then become depressed in the centre, and a zone of redness surrounds the base. Afterwards the pustules dry and form scabs, which finally separate, leaving a smooth, round, or oval scar.

Measles of the Pig.

This disease is due to a parasite, the Cysticercus cellulosus, which, after introduction into the human body, develops into a variety of tapeworm—the Taenia solium. These cysticerci may be so numerous in the flesh of pigs, that on cutting with a knife it crackles. It is not easy to detect the disease during life; but sometimes the parasites may be found in little vesicles under the tongue. By excising a small portion, it may be examined for the parasite. The heads of these are square-shaped, with four suckers, and round the depression at the apex of the head are the characteristic hooklets.

Pigs affected with this parasite are unfit for food.

Various Parasitic Diseases.

Sheep suffer from a disease called "Phthisis," due to the ova of Strongylus filaria; and from Distoma hepaticum, causing "rot." Sturdy, another disease, also called "turnsick," is due to a parasite in the brain, the Coenurus cerebralis.

Oxen suffer from the larval cestode of Taenia medio-canellata.

Sheep scab, a common disease, is caused by a parasite, the Psoroptes ovis. The wool falls off abundantly, and the skin becomes ulcerated and destroyed.

Inspection of Meat.

The remarks already made have referred chiefly to the live but diseased animal, and to some of the appearances which would be found in the carcase if the animal died or had been killed. In the inspection of carcases, the sanitary inspector should direct his attention to the various organs and tissues which become affected in the diseases described; and he will be able generally to detect any deviation from the appearances of healthy carcases, if he is familiar with the characteristic features of the latter. Mere examination of the carcase is not sufficient, but the offal should be examined, as in the lungs, stomach, liver, etc., many

important lesions occur: thus in pleuro-pneumonia the lungs and pleuræ are affected; in anthrax, the spleen is specially affected; and in murrain, the mouth and feet. To become acquainted with the appearances of healthy carcases, the sanitary inspector should study these in the shop of a butcher who is above suspicion.

Meat, shortly after killing, has no reaction, but becomes slightly acid in a few hours afterwards. The flesh should be firm and elastic, not pitting on pressure, nor wet or sodden. There should be no mucilaginous fluid or purulent matter exuding. The section should present, in well-fed cattle, a marbled appearance from the intermixture of fat amongst the muscular fibres. The colour should neither be too pale nor too dark, but have that healthy "bloom" which cannot easily be described. Pork, veal, and lamb are pale in colour. There should be little or no odour; to detect this a long knife or skewer should be thrust into the meat, and quickly withdrawn, when the smell, if any, should be noted. Diseased meat has a sickly smell, and sometimes a smell of physic. Cutting the meat into pieces and drenching it with warm water bring out any smell. When dried at a temperature of 212° F. or so, it should not lose more than 70 to 74 per cent. of its weight. The fat should be firm, and free from blood or bile staining. There should be no sign of the presence of parasites.

Meat may be unwholesome from the animal having been treated by drugs. Examples of this have been known, and one in particular, where 301 persons partook of the flesh of an ox which had been treated during life with potassio-tartrate of antimony; of these, 107 suffered from violent vomiting and purging, and one person died. Arsenic has been found in the tissues of animals in sufficient quantity to produce serious effects.

Decomposing flesh of healthy animals may cause serious symptoms; but some people prefer meat in this state. The American Indians keep their meat till it is putrid. The well-known case of poisoning by ham at Welbeck in 1880 is an example of poisoning due to the ingestion of meat containing microbes. In this case a number of people had partaken of ham, and were afterwards seized with intense diarrhœa and febrile symptoms, and four died. On microscopical examination of

the ham, bacilli were found, which when inoculated into small animals, or on feeding animals with the affected ham, developed the same symptoms as the people who were seized. Subsequent examples similar to the above are now on record; and it should never be forgotten, that all putrefying animal or vegetable matters develop poisonous compounds, called ptomaines, due to the action of micro-organisms on these matters. To assist the sanitary inspector in deciding as to the fitness of meat for human food, the following conditions are quoted from a paper on meat inspection by Prof. Walley.

Conditions which warrant an Inspector of Meat in condemning Animal Flesh for Human Food.

(*a*) An excessively dark colour of the muscles — indicating interference with oxidation.

(*b*) An excessively dark colour, coupled with a deep yellow—indicating interference with oxidation, and absorption and retention of biliary matters.

(*c*) Iridescence of the surface of a cut section—indicating material interference with nutrition of the flesh, and probably some form of degeneration of the muscular elements.

(*d*) A universal magenta or pink colour of the flesh—indicating material changes in the blood itself, and especially the colouring matter of the red cells.

(*e*) A green colour of the flesh—indicating putrefaction.

(*f*) Extravasation of blood into the deeper tissues, or universal superficial extravasation, as indicating also important blood changes.

(*g*) Effusion of serum into the cellular tissues, especially if this effusion is general and deep-seated; and still more particularly if this effusion is tinged with blood and is thrown out in close proximity to the bones; all indicating some form of degradation or depravation of the blood, as the result of fever, organic disease, the action of poisonous and improper dieting.

(*h*) A flabby or flaccid condition of the flesh, particularly if that condition is associated with a soapy feel to the fingers, and if the flesh pits on pressure.

(*i*) Any odour indicating the commencement of putrefaction, particularly if found in close proximity to the bones.

Poultry.

The next form of food on the list which has to be described is poultry.

One of the most important diseases affecting poultry is fowl-cholera. The disease is usually rapidly fatal. When affected the feathers bristle, the wings hang, and the bird is dull and listless; drinks a good deal, but does not eat. Diarrhœa occurs, and blood appears in the evacuations.

The disease is caused by an organism which has been investigated by Pasteur, and is a short rod or bacterium, slightly constricted in the middle so as to resemble the figure 8.

Fowls also suffer from intestinal worms and what are called roup, and diphtheria. The flesh of a fowl which has suffered from fowl-cholera is redder than natural, the liver more friable, and blood is extravasated into the intestines.

Sound fowls should be plump, pinkish in colour, and free from discolourations on the skin; blue and green marks indicate commencing putrefaction; nor should there be any disagreeable odour.

Game.

Owing to the custom of using "high" game, it is seldom that game is found exposed for sale except in such a state of decomposition that would be sufficient to condemn any other article of food. Such "high" game might be seized by an inspector, but it is highly questionable if any magistrate would consider it unfit for food, and there is no medical evidence to support the theory of its unfitness.

Fish.

Fresh fish are firm, without any smell, and when held out in the hand are rigid from the stiffening which occurs after death; the gills are pink, and the eyes full. After keeping, these points indicating good quality disappear, and when decomposition is advanced the fish becomes soft and limpid, the eyes collapse, and smell becomes very pronounced. There are kinds of fish which have inherent qualities, rendering them dangerous for use. Shell-fish often cause nettle-rash. Mackerel, if not immediately used, are highly dangerous, probably from the development of

some poisonous alkaloid in their tissues. Oysters, fed on beds over which sewerage passed, have been considered as causes of disease.

The point, however, which concerns the sanitary inspector most, is the degree of freshness of the fish ; any appearance of decomposition being justification for seizure of fish.

Fruit.

In the case of fruit, decomposition is the only condition which would justify interference on the part of the inspector.

Vegetables.

Under this designation, although not specially mentioned in the Act, must be included all varieties and preparations of vegetables, such as flour, bread, biscuits; but adulterations can be dealt with under a special Act—The Sale of Food and Drugs Act, 1875, and Amendment Act of 1879. At this time we will only refer to the good and bad qualities of certain vegetable articles of food, reserving any remarks on the powers under this Act till another opportunity.

Potatoes should be of good size, firm, and show no appearance of fungi. Such vegetables as cabbage and cauliflower should be fresh, and have none of the appearances of decay.

Many articles now-a-days are preserved in tins, and in this way may become impregnated with tin or lead ; and sometimes a poisonous metal may be fraudulently introduced, as in the case of tinned peas, beans, etc., where sulphate of copper is used to give a fine fresh green appearance to the peas.

In the case of tinned foods—whether vegetables or meats—attention should be paid to the ends of the tins ; if they bulge, this indicates that decomposition has occurred, the bulging being caused by the gases thus generated ; and if there are two solder marks instead of one, these show that decomposition had occurred, and that the maker of the article had perforated the tin to allow the gas to escape and again soldered it up.

Up to this time our remarks have applied to articles unfit for food, and which could be dealt with under the Public Health (Scotland) Act, 1867.

In the following pages, reference will be made to various articles of food which, although they might be of deficient

quality or adulterated to a certain extent, would not be rendered positively unfit for food, and so not come under the Act referred to, but would come under the scope of the Food and Drugs Act.

Flour.

This is usually made from wheat, but also from corn and barley. Wheat flour should be white, or nearly so, smooth to the touch, not gritty or lumpy. A handful when pressed should form a ball, and when thrown against a board some of the flour should adhere to it. To detect impurities or adulterations, it must be examined under the microscope and also chemically. Under the microscope varieties of fungi may be found—the Acarus Farinæ or Weevils. A great many adulterations are introduced into flour, such as the flour of potatoes, barley, oats, rice, maize, rye, etc., and mineral substances as alum, gypsum, clay.

Alum is the commonest mineral substance added, and for the purpose of rendering an inferior flour fit for baking purposes. It may be detected in the manner here described, which is used by Dr. Carter Bell, the distinguished analyst:—

"The reagents required are recently-prepared tincture of logwood and a solution of carbonate of ammonia. The former is prepared by digesting 5 grammes of logwood chips in 100 cubic centimetres of strong alcohol; and the latter by dissolving 15 grammes of carbonate of ammonia in 100 cubic centimetres of distilled water. The test is applied as follows: A small quantity, say 5 grammes of flour, is made into a paste with 5 cubic centimetres of water; one cubic centimetre of logwood solution is then mixed with the paste, and this is followed immediately by the addition of one cubic centimetre of the solution of carbonate of ammonia. If alum be present, the colour produced will be more or less lavender or blue, according to the quantity of alum in the flour; but if the colour be pink, which soon fades to a dirty brown, then, according to our experience, alum is invariably absent. Should there be any doubt as to the colour, the paste is put aside for several hours, and then, if alum be present, even in very small quantity, there will be a decided tinge of lavender on the sides of the capsule near the edge of the partly-dried paste. Obtaining the lavender tinge is not absolutely conclusive

proof of the presence of alum or of any salt of alumina, but it is quite enough to cast some suspicion on the genuineness and wholesomeness of the flour. It is important to note that pure wheat flour has been found to contain a quantity of alumina equivalent to from 2 to upwards of 40 grains of ammonia alum per 4 lbs."

To detect other mineral substances, the flour must be burned down to an ash, which should not exceed 2 per cent., but is increased in proportion to the quantity of mineral added.

Bread.

This important article of food deserves careful attention, as it is frequently of bad quality, and also adulterated. It may be yellowish or blackish in colour from bad flour or admixture with other kinds of flour, or it may be acid from the development of acids, or sodden and heavy from too rapid fermentation. Good bread should be well baked, light and spongy, with a good proportion of crust.

Alum is a very common adulterant, and is detected by the logwood test, applied as follows : A slip of gelatine is soaked in an aqueous solution of the suspected bread, and if there is alum in it the gelatine slips assume a deep blue colour with the logwood solution. Sometimes sulphate of copper is found in bread ; and to detect this a glass rod, dipped in ferrocyanide of potassium is drawn over the cut surface of bread : a brick-red colour indicates its presence. Sulphuric acid is sometimes used for the same purpose as alum.

Powers and Duties of Local Authorities.

Order for the Destruction or Sale of Unwholesome Meat, etc., sect. 26.

ORDER FOR DESTRUCTION OR DISPOSAL OF UNWHOLESOME MEAT, ETC.

[*Place and date.*]

[See Note, p. 246.]

On the Application of , the Sanitary Inspector for , whose signature is accordingly hereto subjoined, and being satisfied that [the carcase of a cow (*or the like*)] seized by him on and found in the possession of or on the premises occupied by at , [is *or* are] unfit for human food, hereby, in virtue of sect. 26 of the Public Health (Scotland) Act, 1867, ordain the said Sanitary Inspector to

destroy the same, or to sell or otherwise dispose of the same in such manner and with such precautions as to prevent the same being exposed for human food, or used for such food.

(*Judge*) [*signature of sheriff, or two justices, or two magistrates.*]
Inspector.

Note.—If it is desired to recover the penalty or expenses mentioned in sect. 26, a summary petition must be presented. The form No. 21 may be adopted for this purpose, and it would be advisable to found on sect. 26, as well as the general section 105.

In addition to the powers which Local Authorities have, under the Public Health (Scotland) Act, to deal with unsound articles of food, they have additional powers, under "The Sale of Food and Drugs Act, 1875," and "Amendment Act of 1879," to deal with the important subject of adulteration of foods and drugs.

Samples may be purchased for purposes of analysis by any medical officer of health, inspector of nuisances, inspector of weights and measures, or any inspector of a market, or any police officer, under the direction and at the cost of the Local Authority appointing such officer, inspector, or constable so charged with the execution of the Act.

Formalities to be Observed.

After purchasing any article—(1.) *Forthwith* notify to the seller, or his agent selling the article, his intention to have the same analysed by the *public analyst.*

(2.) Offer to divide the article into three parts, to be then and there separated, and each part to be marked and sealed, or fastened up in such manner as its nature will permit. If the offer is accepted by the seller or his agent, one part is to be given to him, one to be retained by the purchaser, and one given to the analyst. If not accepted, the article should be given whole to the analyst, who is to divide it into two parts, analyse one, and seal or fasten up the other and give it back to the purchaser, who shall retain the same for production in case proceedings are afterwards taken. A sample of milk may be procured "at the place of delivery" as well as at the sale shop.

INDEX.

PAGE

ACCOMMODATION arrangements, duties of Local Authorities in relation to, ... 70
Accumulation of manure, . . 164
—— Destruction of, . . . 165
—— Storage of, . . . 164
Act, Food and Drugs Adulteration, 246
—— Local Authority defined, . 4
—— Local Government, Scotland, 1–6
—— Public Health Acts transferred to County Council, . . 1–6
—— Rivers Pollution, . . 3
—— Terms of, defined, . . 4
Action of water on pipes, . . 120
Anthrax, ... 235
Air, ammonia in, . . . 43, 58
—— Analysis of, . . . 39
—— Carbonic acid in, . . 40
—— Chemical and physical properties of, ... 39
—— Collection for analysis, . 39
—— Cubic space, . . . 52
—— Sewers, ... 57
—— Soils, ... 27
—— Impurities in, . . . 43, 59
—— Inlets and outlets, . . 51
—— Micro-organisms in, . . 59
—— Necessity of pure, . . 38
—— Organic matter in, . . 42
—— Space of, in relation to mortality, ... 22
—— Water vapour in, . . 42
Albuminoid ammonia in water, to estimate, ... 150
Alum in bread and flour, . . 244
Analysing water, collection of sample, 99
—— Information to be supplied analyst, ... 99
Appeal by medical officer or sanitary inspector, . . . 5
Artificial ventilation, . . . 47
Ashpits, ... 165
Author of nuisance, . . . 8

BAKEHOUSE regulations, . . 180
Baths, ... 123

PAGE

Borrowing powers of Local Authority for water supply, etc., . 132
Brickwork, formula for finding, . 84
Buchanan's' and Pettenkoffer on water in soil, ... 29
Burghs and water supply, . . 132
Burial-grounds, when to be held a nuisance, ... 185
Business, offensive, . . . 169
—— Artificial manure making, . 174
—— Blood boiler, . . . 169
—— Bone-boiling, . . . 170
—— Glue-making, . . . 174
—— Skinner, ... 172
—— Size-making, . . . 174
—— Slaughtering cattle, . . 171
—— —— Other animals, . . 172
—— Soap-boiling, . . . 172
—— Tallow-melting, . . . 173
—— Tanning, ... 170
—— Tripe-boiling, . . . 173
Bye-laws, construction of, . . 154
Byres as a nuisance, . . . 153
—— Cowsheds, etc., Order, . 154

CARBONIC acid, estimation of, . 55
Catch-water ditches, . . . 118
Cellar dwellings, . . . 61
—— Rules for, ... 229
Cemetery, site and soil for, . . 186
—— Space required, . . . 187
Cesspools. *See* Privies.
Charbonous fever, . . . 235
Chemical analysis of water, 101, 144
Chlorides in water, to determine, 145
Cholera and polluted water, . 131
Churchyard. *See* Cemetery.
Common lodging-houses, . . 61, 222
—— Notification of diseases in, 223, 228
—— —— Persons resorting, . 225
—— Rules and regulations, 222, 224
—— Water supply of, . 133, 227
Connecting drains with sewers of Local Authority, . . . 92
County Councils, . . . 1
—— Appoint medical officers, . 1

PAGE

County Councils appoint sanitary inspectors, ... 1
—— Byo-laws for suppression of nuisances, ... 3
—— Provisional Order for joint committees, ... 3
—— Regulations for district committees, ... 4
—— Rivers Pollution Act, . . . 3
—— Services of medical officer and sanitary inspector, . . . 1, 2
Course of sewers, ... 85
Cremation, ... 186
Cubic space, ... 22, 52

Dairies, Cowsheds, and Milkshops Order of 1885, ... 154
—— Regulation of, ... 158
Death-rate reduced by sewage and drainage systems, ... 97
Decomposition of flesh causing unwholesome meat, . . . 240
Defects of structure of houses from drainage, ... 63
—— Floors, ... 36
—— Roofs, ... 35
—— Walls, ... 34
Disease, infectious, notification of, 216
Diseases of animals, measles in pig, ... 238
—— Parasitic, ... 239
—— Pig typhoid, ... 238
—— Variola ovina, ... 238
—— Variola vaccinia, . . . 238
Diseases, filth, ... 70
—— General prevention and mitigation of, ... 190
—— Prevention and mitigation of, by Local Authority, . . . 211
—— —— Under Order in Council, 189
—— Specially associated with pollution of water, ... 131
—— Site of houses, causing, . . 72
Diseases of animals rendering food unsound, ... 230
—— Anthrax, ... 235
—— Cattle plague, ... 234
—— Charbonous fever, . . . 235
—— Foot and mouth disease, . 234
—— Inspection of, . . . 231, 239
—— Parasitic, ... 239
—— Pig Measles, ... 239
—— —— Strangles, ... 238
—— —— Typhoid, ... 238
—— Post-mortem appearances, 233, 237
—— Symptoms of, ... 239
—— Tuberculosis, ... 236
—— Trichinosis, ... 237
—— Variola Ovina, ... 238
—— —— Vaccinia, ... 238
Disinfectants, charcoal, . . . 209

PAGE

Disinfectants, chemical, . . . 205
—— Chlorine gas, ... 207
—— Liquid, ... 208
—— Nitrous acid, ... 207
—— Ozone, ... 207
—— Solid, ... 208
—— Sulphurous acid or sulphur dioxide, ... 207
Disinfection by boiling, . . . 206
—— Chemical means, . . . 206
—— Heat, ... 201
—— Steam, ... 203
Disinfection of body, ... 210
—— Drains, sewers, etc., . . 210
—— Room, ... 209
—— Hotels, ... 214
—— Houses, ... 212
—— Local Authority may order, 212
—— Medical certificate for, . 213
Disinfectors, Fraser's, ... 201
—— Lyon's, ... 203
—— Ransome's, ... 201
—— Scott's, ... 201
Disposal of sewage, ... 88
Distilleries, etc., to construct reservoirs for refuse, and render same unoffensive before entering river, etc., ... 92
Distribution of water, ... 118
District committees, ... 1, 4
Drainage district, special, . . 5, 95
—— Importance of, ... 97
Drains, access holes of, . . . 79
—— Communications with, . 93
—— Disconnections of, . . . 80
—— Joining of, ... 80
—— Local Authority may order, 92
—— Nuisance, ... 78
—— Order to construct, . . . 94
—— Soil pipes, ... 80
—— Traps for, ... 80
—— Under houses and water seats, ... 80
Dysentery associated with polluted water, ... 131

Earth-closets, ... 69
Effects of improved sanitation, . 97
—— Dissolved mineral, etc., in water supply, ... 130
Entry where nuisance suspected, 73

Factory and Workshops Act, . 180
Factory, sanitary inspection of, . 179
Filters for water, ... 125
—— Asbestos and charcoal, . 128
—— Carferal, ... 128
—— Charcoal, ... 126
—— Household, scale of, . . 126
—— How to clean, ... 127
—— Magnetic carbide, . . . 127

PAGE
Filters, Pasteur-Chamberland, . 128
—— Spongy iron, ... 127
Filth diseases, ... 70
Filtration, household scale of, . 126
—— Of sewage, ... 89
Firman's dryer and carbonizer, . 166
Fish, unwholesome, ... 242
Floors, ... 36
Flour, adulteration of, . . . 244
Food, unsound, ... 231
Foot and mouth disease, . . . 234
Form of certificate for admission to premises, ... 73, 75
Form of medical certification of existing nuisance, ... 76
—— For removal of dead body, . 214
—— Disinfection of house, . 213
—— Petition to Sheriff by owner, etc., beyond district to fix terms for communicating with drains, ... 93
—— Destruction of unsound food, 245
—— Requisition for special drainage district, ... 95
—— Sanitary inspector's petition to Sheriff for removal of nuisance, ... 76
—— For water fouling by gas, . 134
—— Water supply for common lodging-house, Local Authority's order, ... 227
Formula for finding thickness of brickwork, ... 81
Forschammer's process for oxidisable matter in water, . . . 147
Fruit, unwholesome, ... 243
Fryer's destructor, ... 166

GAME, unsound, ... 242
General prevention and mitigation of disease, ... 190
Glasgow, exception of, as to police manure, ... 163
Gradients in sewers, ... 85
Gutters, to construct, ... 79

HARDNESS of water, to determine, ... 145
Hospitals, (*see* isolation hospitals), ... 190, 199
—— Local Authority may provide, ... 210
Hotels, etc., not to be let till disinfected, ... 214
Houses let in lodgings, . 228, 229
Houses as nuisances, ... 21
Defect of structure, . . . 25
Soils—sites, ... 25
Air in soils, ... 25
Conformation of soil, . . 30, 31
Ground air, ... 26
PAGE
Made soils, ... 27
Physical and chemical conditions of, ... 32
Pollution of soils, . . . 27
Remedies for, ... 27
Water in soils, ... 27
Defect of ventilation, . . . 38
Air, composition of, . . . 39
Ammonia, ... 43, 44
Oxygen, nitrogen, carbonic acid, ... 40
Ozone, ... 41
Cubic air space, . . 45. 52, 53
Devices for ventilation, . . . 46
Boyle's system, ... 51
Fans, ... 47
Galton's grate, ... 50
George's calorigen, . . . 50
M'Kinnel's tubes, Mure's do., ... 50
Outlets and inlets, . . . 51
Sherringham valve, . . . 49
Schonheyder's stove, . . . 50
Tobin's tubes, ... 49
Varley's system, ... 49
Watson's tube, ... 50
Windows, ... 48
Various unhealthy conditions, 72
Defects of walls, roofs, floors, 35, 36
Water defective, . . 132–133
Houses, insufficiency of size of, . 22, 24
Space in barrack, . . . 22, 24
Dormitories, . . . 22, 24
Glasgow houses, . . . 22, 24
Workhouse, . . . 22, 24
Overcrowding, effects of, . . 23
On infectious diseases, . 24
Overcrowding and nuisances, . 178
Schools and dwellings, . 24
Houses, defects in structure, . 34, 63
—— Disinfection of, for letting, . 214

IMPORTANCE of good sewerage and drainage system, ... 87
Impurities in air from combustion, ... 44
—— From gases, ... 43
—— Detection of, by smell, . 59
—— Respiration, ... 44
—— Suspended matters, . . 43
—— Micro-organisms, . . . 59
—— Special causes, . . . 44
Infected persons entering public conveyance, ... 215
Infectious diseases hospital, . 190
—— Construction of, . . . 193
—— Extent of ground, . . . 197
—— Furnishing of, . . . 196
—— Mortuaries, ... 199
—— Permanent, ... 194
—— Rules for management, . 198

PAGE
Infectious diseases hospital, rules for medical officer, etc., . . . 198
—— Temporary, ... 193
—— Ventilation of, . . . 195
—— Village cottage, . . . 194
Inlets and outlets, ... 49, 51
Inspection of meat, . . . 239
Irrigation under Act, . . . 14
—— Sewage, ... 90

JUNCTION of sewage pipe, . . 85

KOCH'S process of cultivating microbes, ... 138

LIERNUR'S system of sewage removal, ... 88
Local Authority, ... 4
—— Accommodation arrangements, ... 70
—— Demand admission to where nuisance suspected, . . 73, 92
—— Drains for distillery, dwelling-house, etc., . . . 93
—— Factories, ... 178
—— Mortuary, ... 213
—— Manure heaps, . . . 167
—— —— removal, . . . 168
—— Offensive trades, . . . 176
—— Prevention and mitigation of disease, ... 211
—— Sewerage scheme, combined districts, ... 93
—— Sewers, ... 92
—— Smoke nuisance, . . 184
—— Ventilation of inhabited houses, ... 61
—— Water-closets for factories, etc., ... 63
—— Water supply, . . . 132
—— —— Combined, . . . 132

MALARIAL diseases and water, . 131
Manufacturers, ... 169, 177
Manufactures, artificial manure, 175
—— Glue and size, . . . 174
—— Injurious to health, . . 173
Manure, accumulation of, . . 163
—— Collection and storage, . 164
—— Nuisance, ... 164
—— Local Authority to sell, . 167
Manures, collection of, . . 164
—— Manufacture of, . . . 174
Measles in pig, ... 238
Measuring springs, table for, . 109
Meat, inspection of, . . . 239
Medical officer, appointment of, . 1, 5
—— Term of office, . . . 3
Medical officer of health, . . 1
—— Appeal to County Council, . 5
—— Duties of, ... 14–17

PAGE
Medical officer of health, report by, 2
—— Qualifications of, . . . 2
—— Tenure of, ... 3
Metals in water, ... 151
Micro-organism in air, . . . 59, 60
—— Food, . . 235, 236, 238, 241
—— Soils, ... 33
—— Water, ... 138, 144
Micro-organisms, examination of, 143
—— Inoculation with, . . . 143
Microscopic examination of air, . 59
—— Food, ... 231–246
—— Water, ... 101
Microscopical examination of water, ... 137
Milkshops Order, . . . 154, 162
Mitigation of disease, power of Local Authority, . . 210, 211
Mortuaries, ... 199, 200
Mortuary, ... 213

NITRATES in water, ... 146
Nitrites in water, ... 147
Nitrogenous matter, ... 148
Notification of infectious disease, 216
Nuisance arising from burial-grounds, ... 185
—— Manure, ... 164
—— Pig-styes, ... 163
—— Smoke, ... 182
—— Stables, etc., ... 152
Nuisances, author of, ... 8
—— Definition of, ... 21
—— Entry for inspection, . . . 73
—— Section XVI. (A), . . . 21
—— ,, (B), . . . 78
—— ,, (C), . . . 152
—— ,, (D), . . . 163
—— ,, (E), . . . 169
—— ,, (F), . . . 178
—— ,, (G), . . . 178
—— ,, (H), . . . 182
—— ,, (I), . . . 185
—— ,, (J), . . . 185
Nuisances in houses caused by air in soil, ... 26
—— Conformation of soil, . . 30
—— Insufficiency of size, . . 22
—— Physical and chemical condition of soil, ... 32
—— Site, ... 25, 72
—— Structure, ... 25, 34
—— Water in soil, ... 28

OFFENSIVE works and trades, . 177
Organic matter in air, . . . 42, 57
Overcrowding, ... 178
Oxidisable matter in water, . . 147
Oxalic acid solution, ... 55
Oxygen in air, ... 40
Ozone in air, ... 41
—— Disinfectant, ... 207

	PAGE
PARASITIC diseases, ...	239
Penalties for, see subsections structural works for, . .	77
Penalties, exposing infected person, ...	215
—— Commencing offensive trade,	177
—— Letting house or room where infectious case has been lodged, without disinfecting, . .	214
—— Refusing to erect water-closet, etc., ...	71
—— To remove nuisance, . .	77
—— Water pollution, . .	133
—— Unsound meat, exposure for sale, ...	231
Percolation of water influenced by soil, ...	106
—— Polluting water, to prevent,	112
—— Relation to water supply, .	106
Physical examination of water, .	136
—— Character of water, . .	101
Pig-styes, nuisance, . . .	163
Pig-typhoid or hog cholera, . .	238
Pipes for distributing water,	119, 123
—— Junction of, . . .	85
—— Sewer, ...	84
Plumbers, authorised waterworks, only to be employed on Water Companies' water supply, .	124
Polluting rivers, . . .	3
—— Water, penalties, . .	133
Pools, etc., a nuisance, . .	78
Poultry, diarrhœa, . . .	242
—— Diphtheria, . . .	242
Precipitation of sewage, . .	89
Premises defined, . . .	22
Process, against party polluting water, ...	134
—— Appearing, pleading, and suing by Local Authority, .	11
—— Connecting drains with sewers of Local Authority, .	93
—— Demanding admission where nuisance suspected, . . .	73
—— Evidence of meeting of Local Authority, . . .	11
—— Lands Clauses Act enforced,	11
—— Removal of nuisance, . .	75
—— Sheriff, etc., although members of Local Authority, may exercise jurisdiction under Act,	10
—— Sick to infectious hospital, removal of, ...	211
—— Structural works for removal of nuisance, ...	77
Privy acommodation or cesspool, .	68
—— Bad form of, . . .	69
—— Combined with ashpit, conditions required, . . .	68
—— Dry-earth system, . .	69
—— Hull and Glasgow forms, .	68

	PAGE
Privy accommodation, Morrell's ash-closet, ...	69
Proof of existing nuisance, . .	75
Provisional Order, . . .	11, 13
Purchase or taking of land other than by agreement, . .	11
Purification of water by filtration,	125
QUANTITY of water to be supplied,	107
RAINFALL and percolation, .	106, 109
Rain water as a water supply, .	108
Rates, deficiency in, . . .	5
Refuse matter, disposal of, . .	167
Regulation of dairies, etc., . .	158
Removal of infectious sick, . .	211
—— Nuisance where structural work required, . . .	77
—— Sewage, Liernur's system, .	88
—— ,, Shone's ,, .	87
Requisition for sewerage or water district, ...	95
Reservoirs, how to construct, .	117
Rivers pollution, duties and powers of County Council, .	3
Rivers and streams as a water supply, ...	114
Rooms, sanitary examination of, .	52
Rules for common lodging-houses, ...	222, 224
—— Management, etc., of isolation hospitals, ...	198
SANITARY examination of rooms,	52
—— Ammonia, ...	58
—— Carbonic acid, . . .	55
—— Cubic space, . . .	58
—— Impurities detected by smell,	59
—— Inlets and outlets for air, .	53
—— Micro-organisms, . .	59
—— Organic impurities, . .	57
—— Sample of air for analysis, .	55
—— Humidity, ...	53
Sanitary examination of water, .	136
Sanitary importance of water, .	129
—— Offensive trades, . . .	176
Sanitary inspector, appointment of,	1, 5
—— Duties defined by Local Government Board (England), .	17
Scott's system of sewage removal,	89
Sectional form of sewers, . .	84
Sewage, chemical composition of,	82
—— Defined, ...	81
—— Disposal of, by filtration, .	89
—— Irrigation, ...	90
—— —— Subsoil, . . .	91
—— —— Liernur's system, . .	88
—— —— Precipitation, . .	89
—— —— Scott's plan, . .	89
—— —— Shone's system, . .	87
—— —— Whitethread's process,	89

PAGE
Sewage, importance of good system, 97
—— Utilization of, . . . 88
Sewerage schemo, Local Authorities may combine to carry out, 93
Sewers, air of, ... 87
—— Construction, where necessary, ... 78
—— Course of, ... 85
—— Gradients in, . . . 85
—— Local Authorities' duties and powers, ... 92
—— Sectional form of, . . 84
—— Traps for, ... 93
—— Ventilation of, ... 86
Shallow wells, ... 111
Shone's system of sewerage removal, ... 87
Siemens' regenerative gas furnaces, 184
Smoke, effects of, . . . 183
—— Composition of, . . . 183
—— Nuisances, cause of, . . 184
—— —— Remedies for, . . 184
Soils, air in, ... 26
—— Conformation of, . . 30
—— Micro-organisms in, . . 33
—— *Parke* on suitability of various soils for sites, . . 33
—— Physical and chemical condition of, ... 32
—— Relation of, to health, . 25
—— Water in, ... 28
Soil-pipe and water-closet connection, ... 66, 79
Solids in water, to ascertain, . 144
Special drainage district, formation of, ... 95
—— Provisions, ... 5
Springs, measurement of, . . 109
—— Water supply, . . . 109
Stables as a nuisance, . . 152
—— Ventilation of, . . . 152
Storage of water in houses, . . 121
Structure of Houses, defects of floors, ... 36
—— —— Roofs, . . . 35
—— —— Walls, . . . 34
Subsoil Irrigation, . . . 91

TIDAL water, effect of, on wells, . 112
Tinned foods, unwholesome, . 243
Trichinosis, ... 237
Tuberculosis, ... 237
Typhoid fever associated with polluted water, . . . 119

UNHEALTHY houses caused by various conditions, . . . 72
Unsound food, ... 231
—— Bread, ... 245
—— Conditions which warrant condemning, ... 241

PAGE
Unsound food, decomposed flesh,. 240
—— Detection of, ... 240
—— Diseases of animals, . . 232
—— Drugged animals, . . 240
—— Fish, ... 242
—— Flour, ... 244
—— Fruit, ... 243
—— Game, ... 242
—— Local Authority's powers, . 231
—— Penalty for exposing, . . 231
—— Poultry, ... 242
—— Vegetables, ... 243
Upland water supply, how to secure, ... 117
—— Surface, ... 116
Urinals, construction and cleaning, ... 96
—— Local Authority may erect, . 71
Utilization of sewage, ... 88

VACCINATION, ... 217
—— Benefits of, ... 220
—— Local Authority may defray costs, ... 217
Vaccinators under contract, instructions for, ... 217
Variola Ovina, ... 238
—— Vaccinia, ... 238
Vegetables, unsound, . . . 243
Ventilation, ... 38
—— Action of wind on, . . 46
—— Artificial, ... 47
—— Byres, ... 154
—— Devices for house, . . 48
—— Heat combined with, . . 46, 50
—— Hygienic, importance of, . 51
—— Local Authority's powers, . 61
—— London Guildhall system, . 51
—— Necessity of, ... 38
—— Principles of, ... 51
—— Sewers, ... 86
—— Stables, ... 152
Ventilators, fan and screw, . . 47
—— Boyle's inlet, ... 51
—— George's calorigen, . . 50
—— M'Kinnel's, ... 50
—— Mure's, ... 50
—— Outlets and inlets, . . 49, 51
—— Potts' system, ... 49
—— Schonheyder's stove, . . 50
—— Sherringham, ... 49
—— Tobin's tubes, ... 49
—— Varley's system, . . . 49
—— Watson's tubes, ... 58

WANKLYN, Chapman, and Smith process for measurement of nitrogenous organic matter in water, ... 148
Water, albuminoid ammonia in, . 150
—— Analysing, ... 99

PAGE

Water, chemical analysis of, . 101
—— Composition of, . . . 100
—— Distribution of, . . . 118
—— General sources of, . . 104
—— Microscopic character of, 102, 103
—— —— Examination of suspended matter and sediment, . 137
—— Oxidisable matter in, . . 147
—— Parasites introduced into human body by, . . . 131
—— Physical character of, . 101, 102
—— Pollution of, by percolation, 112, 119, 123
—— —— Organic matter, etc., . 131
—— Purification of, . . . 128
—— Sanitary examination of, . 136
—— —— Importance of, . . 129
—— Softening of, . . . 129
—— Soils, ... 28
—— Specifically polluted, . . 131
—— Storage of, in houses, . . 121
—— Purification of, by boiling, . 128
—— —— Distillation, . . 128
—— —— Exposure to air, . . 128
—— —— Filtration, . . . 126
—— —— Without filtration, . 128
Water-closets, application of, and causes of failure, . . . 66
—— Connection between, and soil pipes, ... 66, 79
—— Precautions as to, . . 65
—— Situation of, . . . 65
—— Suitable, defined, . . 63, 67
—— Varieties of, . . . 64, 67
Water Company, execute necessary repairs, ... 123
—— Plumber, authorised, . . 124
Water Company, regulations for supply by, ... 121

PAGE

Water supply for trades, etc., open to inspection, ... 123
Watercourses and ditches as nuisances, ... 78
Water filtration, . . . 125
Water in soils in relation to building, ... 30
—— In relation to health, . . 28
Water meters, ... 119
Water supply district, . . 5
Water and water supplies, . . 98
Water supply, effects of defective, 130
—— —— Dissolved mineral, . 130
—— —— Metallic impurities, . 130
—— —— Suspended animal matters, ... 130
—— —— —— Mineral matters, . 130
—— —— —— Vegetable matters, 130
—— —— Local Authority, powers and duties of, ... 131
—— —— Pollution of, . . 131
—— —— Quantity of, . . 107
—— —— Rain water as, . . 108
—— —— Rivers and streams as, 114
—— —— —— Medical report on, 116
—— —— Upland surface as, . 116
—— —— Wells as, . . . 110
Wells, Artesian wells, . . 113
—— Classification of, . . . 113
—— Pollution of, . . 111, 113
—— Sources of water supply, . 110
—— Tidal water, effect on, . 112
—— Tube, ... 113
Whitethread's process for sewage removal, ... 89
Wind and ventilation, . . 46
Works and shops, offensive, . 169
Workshops, sanitary inspection of, ... 179

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